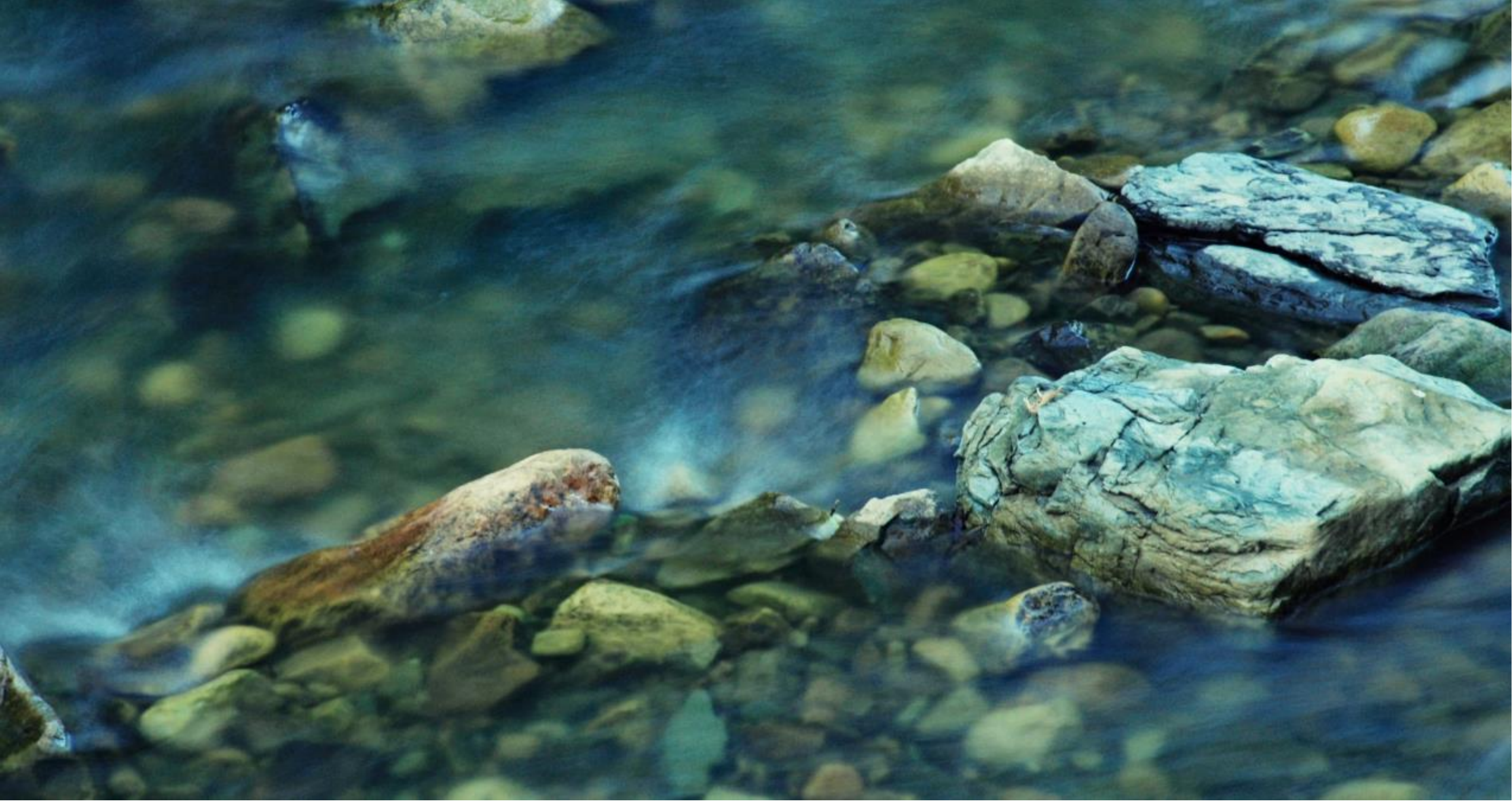

November 2018
Port of Seattle T-25 South Design Characterization

Port of Seattle

Quality Assurance Project Plan: Soil and Subsurface Sediment Characterization

Prepared for U.S. Environmental Protection Agency

November 2018
Port of Seattle T-25 South Design Characterization

Quality Assurance Project Plan: Soil and Subsurface Sediment Characterization

Prepared for

U.S. Environmental Protection Agency
Region 10
Seattle, Washington

Prepared by

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Project Number: 160003-03.01
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APPROVAL PAGE

Approved by: ______________________________ Date: ______________
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Anchor QEA, LLC, Quality Assurance Manager

Approved by: ______________________________ Date: ______________
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Approved by: ______________________________ Date: ______________
USEPA Technical Lead

Approved by: ______________________________ Date: ______________
USEPA Quality Assurance Officer

DISTRIBUTION LIST

This list identifies all individuals who will receive a copy of the approved quality assurance project plan, either in hard copy or electronic format, as well as any subsequent revisions.

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ABBREVIATIONS

%RSD	percent relative standard deviation
µg/kg	micrograms per kilogram
ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials International
BEI	Blymyer Engineers, Inc.
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
City	City of Seattle
COC	chain of custody
COPC	contaminant of potential concern
CSL	cleanup screening level
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
DQI	data quality indicator
DQO	data quality objective
dw	dry weight
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
FC	field coordinator
FS	Feasibility Study
GC/MS	gas chromatography/mass spectrometry
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HPAH	high-molecular-weight polycyclic aromatic hydrocarbons
HASP	health and safety plan
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
LCS	laboratory control sample
LUST	leaking underground storage tank
MDL	method detection limit
mg/kg	milligrams per kilogram
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate

MTCA	Model Toxics Control Act
NAD83	North American Datum of 1983
OHWM	ordinary high water mark
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
Port	Port of Seattle
PM	project manager
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QL	quantitation limit
RPD	relative percent difference
SCO	Sediment Cleanup Objective
SDG	sample delivery group
SMS	Washington State Sediment Management Standards
SOP	standard operating procedure
SPT	standard penetration test
SRI	Supplemental Remedial Investigation
SRM	standard reference material
SVOC	semivolatile organic compound
T-25S	Terminal 25 South
TCLP	toxicity characteristic leaching procedure
TM	task manager
TOC	total organic carbon
TPH	total petroleum hydrocarbons
USCG	U.S. Coast Guard
VOC	volatile organic compound
WAC	Washington Administrative Code
Windward	Windward Environmental LLC

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for collecting and chemically analyzing samples from soil borings and sediment cores in the vicinity of the Port of Seattle (Port) Terminal 25 South (T-25S; Figure 1) to support the habitat restoration project being proposed by the Port at this location. Data from this investigation will be used to characterize the chemical and geotechnical properties of sediment and soil to support habitat restoration planning and waste characterization for soil and sediment.

This QAPP presents the project objectives, existing data summary, and study design, including details on project organization, field data collection, laboratory analysis, and data management. This QAPP was prepared in accordance with U.S. Environmental Protection Agency (EPA) guidance for preparing QAPPs (EPA 2002).

This plan is organized into the following sections:

- Section 2 – Project Objectives and Background
- Section 3 – Project Organization and Responsibilities
- Section 4 – Data Generation and Acquisition
- Section 5 – Assessment and Oversight
- Section 6 – Data Validation and Usability
- Section 7 – References

A health and safety plan (HASP) designed to protect on-site personnel from physical, chemical, and other hazards posed during field sampling activities is included as Appendix A. Field collection forms are included as Appendix B. Appendix C provides the historical boring logs from previous upland studies and also includes a summary of analytical results from the Supplemental Remedial Investigation (SRI; Windward and Anchor QEA 2014) for sediment sampling locations adjacent to T-25S.

1.1 Restoration Project Description

The T-25S restoration project includes restoration of intertidal and shallow subtidal habitat within and around the footprint of a derelict creosote-piling dock structure, in addition to fill removal from more than 5 acres of adjacent uplands, to create off-channel emergent marsh and riparian habitat. The project will be significant in that it is located in a critical estuarine/marine transition area, important to juvenile salmon. In addition, fine-grained intertidal habitat is rare in the East Waterway and no emergent marsh or riparian resources are present.

Preliminary design has been completed for the restoration project. The project will involve removal of the remaining creosote timber piling, connecting timbers, concrete decking, and associated structures within the footprint of the former dock, which is located between -30 and +10 feet mean lower low water (MLLW) (Figure 2). In addition, approximately 250 cubic yards of in-water rubble, riprap, debris, and abandoned material will be removed from intertidal and shallow subtidal areas.

Existing topography in the upland area ranges from +12 to +16 feet MLLW (Figure 2). Soil excavation will extend between 400 and 750 feet landward from the ordinary high water mark (OHWM), depending on final design, to achieve off-channel emergent marsh elevations of between +5.5 feet MLLW to +12 feet MLLW. The Port anticipates removing up to 60,000 cubic yards of previously filled upland soil to create the off-channel marsh. All excavation areas will be backfilled with 1 to 2 feet of imported substrate to support habitat functions, depending on the location and elevations of each area. The inlet and outlet of the off-channel habitat will be graded to +5.5 feet MLLW, while the off-channel area will be graded to have a central high point, or saddle, at +9.5 feet MLLW to ensure drainage and prevent fish isolation during extreme low tides. A riparian buffer will line the landward margin of the site and be densely planted with native trees and shrubs.

An intertidal berm will extend along the current waterward margin of the site with wide channel openings at the north and south boundary. The berm will crest at around +13 feet MLLW and will be constructed of anchored and partially buried large woody debris, interplanted with native emergent and transitional vegetation. Off-channel habitat will extend from the berm landward at a 10:1 to 25:1 slope throughout the off-channel area. The on-channel slope will not exceed 6:1 and will gradually transition to existing subtidal slope conditions of the East Waterway with a series of flat intertidal and subtidal benches.

Depending on the location of planned Sound Transit light rail lines that are conceptually proposed just north of Spokane Street, the southern project boundary could be shifted north and the eastern project boundary could be extended farther east. Along the east side of the restoration area, a stormwater pond may be installed that will retain and treat stormwater from the nearby developed areas and be released as a source of freshwater to the restoration area. Public access and a potential trail may also be added to the south and east edges of the project area.

1.2 Regulatory Context

The sediments within the East Waterway are part of the East Waterway Operable Unit (OU) of the Harbor Island Superfund Site. EPA is overseeing the completion of a Supplemental Remedial Investigation/Feasibility Study (SRI/FS) for the East Waterway OU. The SRI was approved by EPA in 2014 (Windward and Anchor QEA 2014), which included the baseline ecological risk assessment, baseline human health risk assessment, and assembled data to identify the nature and extent of contamination in the East Waterway, evaluate sediment transport processes, and identified potential sources and pathways of contamination to the East Waterway. The FS develops and evaluates East Waterway-wide remedial alternatives to address risks posed by contaminants of concern within the East Waterway and is expected to be approved by EPA in 2018. EPA will release a Proposed Plan in

2018 or 2019 that will identify a preferred remedial alternative for the East Waterway. After public, state, and tribal comments on the Proposed Plan, EPA will select the final remedial alternative in the Record of Decision.

Information from the SRI on the nature and extent of contamination of the sediments in the vicinity of T-25S is summarized in Section 2.5 and was used to develop the sampling program described in this QAPP. Remedial technologies that could be employed to address sediment contamination at T-25S are described in the FS. Specifically, all active remedial alternatives include removal of approximately 1,000 treated piles along T-25S (piling field) and removal of contaminated sediment in the piling field area. Two technologies are evaluated for contaminated sediments in the T-25S area: 1) removal; or 2) partial removal and cap (with partial dredging depths assumed to be equivalent to the cap thickness). While the selected remedy in this area will not be identified until 2019 or later, the data to be collected that are described in this QAPP are intended to support planning and design of the T-25S restoration project so that it is compatible with any of the remedial alternatives that will be selected by EPA. While construction of the T-25S project may occur prior to cleanup of the entire East Waterway, the Port will coordinate with EPA during future restoration planning and design to support completion of this high priority project without limiting future cleanup actions in the East Waterway.

2 Project Objectives and Background

This section describes the overall project objectives and presents the site history and existing information used to inform development of this QAPP.

2.1 Project Objectives

Upland borings and sediment cores will be collected to characterize the pre-construction conditions at T-25S prior to the restoration. Data quality objectives (DQOs) for the characterization area are listed below:

1. Characterize the excavated sediment and soil for disposal characterization.
2. Characterize the post excavation surface prior to the placement of fill material.
3. Characterize the sediment and soil geotechnical properties for static and seismic stability evaluations.

The following matrix provides the step-by-step DQO development process used to establish the sampling design.

DQO Development Matrix

DQO Step	DQO 1	DQO 2	DQO 3
STEP 1: State the problem.	Soil and sediment chemistry is needed for proper disposal of excavated material.	The post-excavation surface conditions are needed to evaluate conditions prior to fill material placement.	Soil and sediment geotechnical data are needed to conduct static and seismic stability evaluations.
STEP 2: Identify the goals of the study.	Establish soil and sediment chemical concentrations for excavated material.	Characterize the post excavation soil and sediment chemistry concentrations.	Characterize geotechnical properties of soil and sediment within the site.
STEP 3: Identify the information inputs.	Existing soil and sediment data were reviewed. Sample locations selected based on existing data and preliminary design.		
STEP 4: Define the boundaries of the study.	Preliminary design information used to identify areas where sediment and soil will be removed.	Preliminary design information used to identify post-excavation elevations.	Preliminary design information used to identify representative areas for geotechnical evaluations.
STEP 5: Develop the analytical approach.	Composite samples will be created to chemically characterize excavated material.	Soil boring and sediment core sections will be analyzed as individual samples to chemically characterize post-excavation concentrations.	Standard penetration tests and deeper borings will be conducted to supplement geotechnical testing of representative areas.

DQO Step	DQO 1	DQO 2	DQO 3
STEP 6: Specify performance or acceptance criteria.	Disposal regulations will determine the suitability of the material for disposal.	Sediment and soil concentrations will be compared to applicable sediment criteria.	Industry standards (i.e., American Society for Testing and Materials) will be used to evaluate the geotechnical properties of remaining subsurface soils and sediments.

2.2 Site Use History

T-25S was initially constructed by dredging and filling activities in the early 1900s, when the Duwamish River was reconfigured to the current channel location. In addition to sediment fill placement at T-25S, other upland fill materials (associated with the regrading of Beacon Hill and Denny Hill) were placed. From 1915 to approximately 1930, the location of the proposed restoration project on T-25S was used for cold storage, logging facilities, and as a sawmill. By 1930, the mill operations were expanded. The mill site was removed to allow for lumber storage and automobile staging in the early 1960s. Additional automobile undercoating facilities were constructed in the 1970s. T-25S was acquired by the Port in the late 1970s. During the 1980s, T-25S was used for cold storage, seafood processing, and shipping operations. Most structures and buildings were demolished at T-25S in the 1990s, with the cold storage building demolished in the early 2000s.

2.3 Current Site Use

T-25S is bounded to the east by East Marginal Way, to the south by Spokane Street, to the west by the East Waterway, and to the north by the active terminal facility (Figure 1). The Port currently leases T-25S to various tenants who use the area for equipment and material lay-down, light industrial activity, and truck parking. The southeastern portion of T-25S includes the City of Seattle's (City's) right-of-way and is used as a paved, active construction laydown area. The south-central portion of T-25S is paved with asphalt and is used as a parking area for trucks. The northern portion of T-25S is currently leased by a tenant to the Port and used for concrete crushing and recycling operations. The western portion of T-25S contains paved and unpaved portions and abuts the eastern shoreline of the East Waterway. The southwestern portion of T-25S is used as a log and woody debris storage area. The western and northwestern areas of T-25S are currently unused.

2.4 Existing Upland Areas Data Summary

Existing soil and intertidal bank sediment characterization results from within the T-25S project boundary are summarized in the following subsections. Figure 3 shows historical upland and sediment sampling locations, exceedances of Sediment Management Standards (SMS) marine sediment criteria, and other historical features are described in this section.

2.4.1 Blymyer Engineers, Inc. (1989)

A Phase 1 Environmental Site Assessment (ESA) was performed on behalf of Matson Terminals, Inc. (a previous tenant), by Blymyer Engineers, Inc. (BEI; BEI 1989), and included historical research and completion of a series of soil explorations. BEI drilled 12 soil borings (B-1 through B-12) throughout the site to an approximate depth of 10 feet below ground surface (bgs). Boring locations were selected based on historical research of past site uses, and only three of the 12 borings were located within the current Project Area (B-10, B-11, B-12; Figure 3). Boring logs are included in Appendix C.

Soil samples from explorations completed on the site were analyzed for one or more of the following analyses: total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), and/or semivolatile organic compounds (SVOCs). Notable exceedances of soil criteria included the following:

- Boring B-12 at 10 feet: TPH-diesel, TPH-oil and grease
- Boring B-10 at 10 feet: polycyclic aromatic hydrocarbons (PAHs: naphthalene, acenaphthene, fluorene, phenanthrene, anthracene, 2-methylnaphthalene)

As reviewed in Landau and EcoChem 1990 (see Section 2.4.3), the field collection and analytical methods utilized in this study may have overestimated TPH at Boring B-12. The analytical method used for these data (EPA 503E/418.1) may not have utilized a silica gel cleanup, which can result in a high biased concentration due to organic material in the soil. Additionally, the degree to which the field team homogenized the sample interval is unclear. A sample location is planned near B-10 to assess chemical quality in this area with potential elevated PAHs.

2.4.2 Sweet-Edwards/EMCON, Inc. (1990)

A Subsurface Investigation Report was prepared by Sweet-Edwards/EMCON, Inc. (1990), on behalf of the Port, to document the excavation and removal of a 3,000-gallon gasoline underground storage tank from the southwestern portion of the site in 1989. Soil samples were collected from the excavation area, and four groundwater monitoring wells (MW-1 through MW-4) were installed (Figure 3). Soil and groundwater samples were analyzed for petroleum-related benzene, toluene, ethylbenzene, and xylene (BTEX) and TPH compounds. Boring logs are included in Appendix C.

Post-excavation soil samples indicated no exceedance of Washington State Model Toxics Control Act (MTCA) soil criteria. Groundwater quality indicated no exceedance of MTCA clean-up levels for groundwater. These groundwater monitoring wells were decommissioned and are no longer present on the site.

In 2012, T-25S received a no further action determination by the Washington State Department of Ecology (Ecology) establishing that no further remedial action was necessary at the site to clean up contamination associated with leaking underground storage tank (LUST) ID 1591 (Ecology 2012).

2.4.3 Landau Associates, Inc. and EcoChem, Inc. (1990)

A Soil and Groundwater Investigation was performed near the location of a former maintenance building in the southwestern portion of the site to characterize the chemical nature of soil and groundwater in the vicinity of BEI's Phase 1 ESA boring location B-12 (Landau and EcoChem 1990). Three borings (LW-1, LW-2, and LW-3) were drilled, and groundwater monitoring wells were installed in the vicinity of B-12 to assess potential TPH impacts in nearshore soil and groundwater (Figure 3). Boring logs are included in Appendix C.

Three soil samples were submitted for analysis of TPH (EPA Methods 418.1/Modified 8015) based upon field screening methods indicating potential presence of contamination. Groundwater samples collected from each well were submitted for analysis of TPH by Modified EPA Method 8015. While low levels of TPH (20 to 95 parts per million) were measured in subsurface soil, concentrations were not detected in groundwater samples. The soil and groundwater concentrations did not trigger reporting to Ecology. Location LW-1 was located adjacent to where Blymyer (BEI 1989) had reported elevated hydrocarbons in location B-12, but as mentioned in Section 2.4.1, field collection and analytical methods utilized in Blymyer (BEI 1989) may have overestimated hydrocarbons at that location. The groundwater monitoring wells were decommissioned and are no longer present on the site.

2.4.4 Pinnacle Geosciences, Inc. (2003)

A Phase 1 ESA at the T-25S was completed by Pinnacle GeoSciences, Inc., for the Port in September 2003 (Pinnacle Geosciences 2003). Results provide an inventory and overview of potential environmental considerations related to soil and groundwater contamination that could affect future redevelopment of the site. The Phase 1 ESA at T-25S includes summaries of environmental investigations completed at the site through 2003 and identifies "Recognized Environmental Conditions" based on research and results of those investigations. Key historical structures and operations within the T-25S project boundary include the compressor building, vehicle and equipment maintenance building, automobile preparation facility, two sawmills, and a UST (see Figure 3 for the approximate location of key historic features). Possible contamination from historic structures and operations at the site include TPH, solvents (petroleum-based or chlorinated), PCBs, metals, and paint.

2.4.5 Shannon and Wilson (2008)

One exploratory soil boring (B-1; Figure 3) was drilled to a depth of 81.5 feet to perform geotechnical engineering analyses regarding the installation of new light poles at T-25S (Shannon and Wilson 2008). While no chemical analysis was conducted on the soil, the subsurface soil conditions summarized in this study will be incorporated into the geotechnical evaluation of the proposed habitat restoration activities. The boring log is included in Appendix C.

2.4.6 Anchor QEA and Aspect (2012)

A site investigation was conducted at T-25S to evaluate potential contaminant migration pathways from the upland to the East Waterway OU (Anchor QEA and Aspect 2012). Samples of nearshore groundwater and intertidal bank sediments were collected and analyzed for contaminants of potential concern (COPCs) including metals, SVOCs, PAHs, and PCBs.

Four shallow groundwater wells (AQ-MW-1 to -4) were installed along the nearshore portion of the site to assess the quality of groundwater discharging from the site to the East Waterway (Figure 3). Concentrations of COPCs in groundwater were below the established East Waterway reference values and marine ambient water quality criteria with the exception of acenaphthene and bis(2-ethylhexyl) phthalate in two samples.

Two intertidal bank composite sediment samples were collected (CSS-1 and -2) to assess surface sediment quality in the upper intertidal area of the site (Figure 3). Exceedances of SMS criteria in sample CSS-1 include pentachlorophenol and PAHs, which were attributed to the existing creosote-treated lumber pilings adjacent to the sampling area.

Boring logs for the groundwater well borings are included in Appendix C.

2.5 Existing Sediment Data Summary

Existing sediment characterization results adjacent to T-25S in the East Waterway are summarized in the East Waterway SRI (Windward and Anchor QEA 2014). Limited intertidal samples were collected from the piling field area by hand, but no subtidal surface or subsurface sediment samples within the T-25S boundary because of the safety concerns associated with sampling within the derelict piling field. The fact that additional sampling would occur in this area associated with the design and construction of the habitat project was acknowledged in the SRI. The existing sediment data characterize the shallow main body of the East Waterway, which is distinct from the T-25S vicinity and may not be representative of conditions at T-25S.

2.5.1 Surface Sediment

Four surface sediment grab samples were collected in the shallow main body of the East Waterway adjacent to T-25S (EW09-SS-015, EW09-SS-016, EW09-SS018, and EW09-SS020). The phenanthrene concentration in EW09-SS-015 exceeded the Sediment Cleanup Objective (SCO) and there was an SCO exceedance in the bioassay testing for this location. EW09-SS-016 exceeded the SCO for total PCBs. EW09-SS-018 exceeded both the SCO and the cleanup screening level (CSL) for PAHs and EW09-SS-020 exceeded the CSL for mercury.

In addition to the discrete sediment samples, intertidal sediment in this area was characterized as composite samples. Three composite samples in the T-25S area were analyzed for PAHs (EW10-04-

COMP, EW10-05-COMP, and EW10-06-COMP). The PAH concentrations in all three samples were elevated with high-molecular-weight polycyclic aromatic hydrocarbons (HPAH) above the SCO for all three samples with concentrations ranging from 15,100 to 167,000 micrograms per kilogram dry weight (µg/kg dw).

The complete sediment dataset for the surface sediment samples in the vicinity of T-25S is provided in Appendix C.

2.5.2 Subsurface Sediment

Three sediment cores were collected in the vicinity of T-25S for the SRI (EW10-SC06, EW10-SC08 and EW10-SC09). Intervals in all three cores exceeded SMS for mercury and PCBs. In addition, PAH concentrations exceeded SMS in intervals in EW10-SC08 and EW10-SC09. The complete sediment dataset for the subsurface sediment samples in the vicinity of T-25S is provided in Appendix C.

2.6 Project Approach and Schedule

Upland borings and sediment cores will be collected in one field event to be conducted in the summer of 2018. The collected data will inform planning and design for the habitat project in 2019.

3 Project Organization and Responsibilities

This section describes the overall management structure of the project, identifies key personnel, and describes their responsibilities, including field coordination, QA and quality control (QC), laboratory management, and data management. The Port and EPA will be involved in all aspects of this project because of the work in and adjacent to the East Waterway OU of the Harbor Island Superfund site, including the discussion, review, and approval of the QAPP and the interpretation of the results of the investigation.

3.1 Project Organization and Team Member Responsibilities

3.1.1 Project Management

The Port of Seattle will be represented by its project manager (PM), Brick Spangler. Mr. Spangler can be reached as follows:

> Mr. Brick Spangler
> Port of Seattle
> P.O. Box 1209
> Seattle, WA 98111
> Telephone: 206-787-3193
> E-mail: spangler.b@potseattle.org

EPA will be represented by its PM, Ravi Sanga. Mr. Sanga can be reached as follows:

> Mr. Ravi Sanga
> U.S. Environmental Protection Agency, Region 10
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> ECL-111
> Seattle, WA 98101
> Telephone: 206-553-4092
> Facsimile: 206-553-0124
> E-mail: Sanga.Ravi@epamail.epa.gov

Dan Berlin will serve as the Anchor QEA PM and will be responsible for overall project coordination, providing oversight on planning and coordination, work plans, all project deliverables, and for the performance of the administrative tasks needed to ensure timely and successful completion of the project.

Dan Berlin
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Telephone: 206-903-3322
E-mail: dberlin@anchorqea.com

Joy Dunay will serve as the Anchor QEA task manager (TM) and Susan McGroddy, PhD, will serve as the Windward TM. The TM is responsible for project planning and coordination, production of work plans, production of project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The TM is responsible for communicating with the PM on the progress of project tasks and any deviations from the QAPP. Significant deviations from the QAPP will be further reported to the Port and EPA. Ms. Dunay can be reached as follows:

Joy Dunay
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Telephone: 206-903-3320
E-mail: jdunay@anchorqea.com

Susan McGroddy, PhD
Windward Environmental
200 West Mercer Street, Suite 401
Seattle, WA 98119-3958
Telephone: 206-812-5421
E-mail: susanm@windwardenv.com

3.1.2 Field Coordination

Evan Malczyk will serve as the Anchor QEA field coordinator (FC). The FC is responsible for managing the field sampling activities and general field and QA/QC oversight. He will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and will oversee delivery of environmental samples to the designated laboratories for chemical analysis. Mr. Malczyk can be reached as follows:

Evan Malczyk
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Telephone: 206-219-5891
E-mail: emalczyk@anchorqea.com

JoDee Taylor, PE, will serve as the Anchor QEA geotechnical engineer and will oversee the collection of geotechnical samples. Ms. Taylor can be reached as follows:

JoDee Taylor, PE
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Telephone: 206-903-3397
E-mail: jtaylor@anchorqea.com

Shawn Hinz (or other qualified personnel) will serve as the boat captain for the vibracorer sampling. The boat captain is responsible for operating the boat and for decisions related to boating operations. The boat captain will work in close coordination with the FC to ensure that samples are collected consistent with the methods and procedures presented in this QAPP.

Shawn Hinz
32617 SE 44th Street
Fall City, WA 98024
Telephone: 425-281-1471
E-mail: shawn@gravitycon.com

Holt Drilling, Inc. (Steve Rasmussen) will serve as the drilling company for upland and intertidal sampling. The driller is responsible for operating the drill rig and collecting sonic boring samples and geotechnical samples. The drilling lead will work in close coordination with the FC and geotechnical engineer to ensure that samples are collected consistent with the methods and procedures presented in this QAPP.

Steve Rasmussen
10621 Todd Road E
Puyallup, WA 98372
Telephone: 253-604-4878
E-mail: srasmussen@holtservicesinc.com

3.1.3 Quality Assurance

Cheronne Oreiro will serve as QA manager and coordinator for chemical analyses for the project. As the QA manager, she will provide oversight for both the field sampling and laboratory programs and will supervise data validation and project QA coordination. Ms. Oreiro can be reached as follows:

Cheronne Oreiro
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Telephone: 206-903-3310
E-mail: coreiro@anchorqea.com

The QA/QC manager will ensure that samples are collected and documented appropriately and coordinate with the analytical laboratories to ensure that QAPP requirements are followed.

Laboratory Data Consultants will provide independent third-party review and validation of analytical chemistry data. Christina Rink will act as the data validation PM and can be reached as follows:

Ms. Christina Rink
Laboratory Data Consultants
2701 Loker Avenue West, Suite 220
Carlsbad, CA 92010
Telephone: 760-827-1100, ext. 161
E-mail: crink@lab-data.com

3.1.4 Laboratory Project Management

Analytical Resources, Inc. (ARI) and Analytical Perspectives will perform chemical analyses. Amanda Volgardsen will serve as the laboratory PM for ARI. The laboratory PMs can be reached as follows:

Ms. Amanda Volgardsen
Analytical Resources, Inc.
4611 S 134th Place, Suite 100
Tukwila, WA 98168
Telephone: 206-695-6207
E-mail: amanda.volgardsen@arilabs.com

The laboratory will accomplish the following:

- Adhere to the methods outlined in this QAPP, including those methods referenced for each procedure
- Adhere to documentation, custody, and sample logbook procedures
- Implement QA/QC procedures defined in this QAPP
- Meet all reporting requirements
- Deliver electronic data files as specified in this QAPP
- Meet turnaround times for deliverables as described in this QAPP
- Allow EPA and the QA/QC third-party auditors to perform laboratory and data audits

3.1.5 Data Management

Ms. Ivy Fuller will oversee data management to ensure that analytical data are incorporated into the East Waterway database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the habitat restoration project. Ms. Fuller can be reached as follows:

Ms. Ivy Fuller
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101
Telephone: 509-293-8733
E-mail: ifuller@anchorqea.com

3.2 Special Training/Certification

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. The federal regulation 29 Code of Federal Regulations (CFR) 1910.120 requires training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet the Occupational Safety and Health Administration regulations.

3.3 Documentation and Records

The following sections describe documentation and records needed for field observations and laboratory analyses.

3.3.1 Field Observations

All field activities will be recorded on a daily log maintained by the FC. The daily log will provide a description of all sampling activities, conferences associated with field sampling activities, sampling personnel, and weather conditions, plus a record of all modifications to the procedures and plans identified in this QAPP and the HASP (Appendix A). All entries will be made in indelible ink. The daily log is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

The following forms, included as Appendix B, will also be used to record pertinent information during core collection and processing:

- Sediment core collection log

- Sediment core processing log
- Upland boring log

3.3.2 Laboratory Records

The laboratory record requirements for the sediment chemistry data are described below. All of the contract laboratories to be used for this investigation are accredited by Ecology.

The chemistry laboratory will be responsible for internal checks on sample handling and analytical data reporting and will correct any errors identified during the QA review. Data packages from the laboratories will be submitted electronically and will include the following:

- **Project narrative:** This summary, in the form of a cover letter, will present any problems encountered during any aspect of analysis. The summary will include, but not be limited to, a discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.
- **Records:** Legible copies of the chain-of-custody (COC) forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample results:** The data package will summarize the results for each sample analyzed. The summary will include the following information, as applicable:
  - Field sample identification (ID) code and the corresponding laboratory ID code
  - Sample matrix
  - Date of sample extraction/digestion
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Percent moisture in the samples
  - Identification of the instruments used for analysis
  - Method detection limits (MDLs) and quantitation limits (QLs)
  - All data qualifiers and their definitions
- **QA/QC summaries:** These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information as that required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below.
  - The calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation (%RSD), relative percent differences (RPDs), and

retention time for each analyte will be listed, as appropriate. Results for standards analyzed at the QL to determine instrument sensitivity will be reported.

  - The internal standard area summary will report the internal standard areas, as appropriate.
  - The method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.
  - The surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
  - The matrix spike (MS) recovery summary will report the MS or MS duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included in the data package. The RPD for all MS/MSD analyses will be reported.
  - The laboratory replicate summary will report the RPD for all laboratory replicate analyses. The QC limits for each compound or analyte will be listed.
  - The standard reference material (SRM) analysis summary will report the results and recoveries of the SRM analyses and list the accuracy for each analyte, when available.
  - The laboratory control sample (LCS) analysis summary will report the results of the analyses of the LCS. The QC limits for each compound or analyte will be included in the data package.
  - The relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.

- **Original data:** Legible copies of the original data generated by the laboratory will be provided, including the following:
  - Sample preparation, extraction/digestion, and cleanup logs
  - Instrument analysis logs for all instruments used on days of calibration and analysis
  - Chromatograms for all samples, blanks, calibration standards, MS/MSD, laboratory replicate samples, LCS, and SRM samples for all gas chromatography analyses
  - Reconstructed ion chromatograms of target chemicals detected in the field samples and method blanks for all gas chromatography/mass spectrometry (GC/MS) analyses
  - Enhanced and unenhanced spectra of target chemicals detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all GC/MS analyses
  - Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MS/MSD, laboratory replicates, LCS, and SRMs

The contract laboratories for this project will submit data electronically in EarthSoft EQuIS® four-file format. Additional electronic data deliverable information will be communicated to the laboratories by the project QA/QC coordinator or data manager. All electronic data submittals must be tab-delimited text files with all results, MDLs, and QLs reported to the appropriate number of significant figures.

3.3.3 Data Reduction

Data reduction is the process by which original data are converted or reduced to a specified format or unit to facilitate the analysis of the data. For example, a final analytical concentration may need to be calculated from a diluted sample result. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the laboratory PM, the project QA/QC coordinator, and independent reviewers. The data will be generated in a form amenable to review and evaluation. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

During chemical analysis, samples are occasionally diluted after the initial analysis if the estimated concentration curve for one or more of the target analytes is above the calibration curve. In these instances, concentrations from the initial analysis will be identified as the "best result" for all target analytes other than the chemical(s) that was originally above the calibration range. The "best result" for this qualified analyte(s) will be taken from the diluted sample.

3.3.4 Data Report

A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples. At a minimum, the following will be included in the data reports:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Copies of field forms
- Summary spreadsheet containing information from field forms
- Sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- Plan view of the project showing the actual sampling locations
- Summary of the QA/QC review of the analytical data
- Data validation reports (appendices)
- Results from the analysis of field samples (including field QC samples), both as summary tables in the main body of the report and appendices with data forms submitted by the laboratories and as crosstab tables produced from the project database

Analytical data will be validated within 4 weeks of the receipt of data packages from the laboratories. A draft data report will be submitted to EPA approximately 4 weeks after data validation is complete. A geotechnical evaluation may be provided in a separate deliverable at a later date. Once the data report has been approved by EPA, the data will be uploaded to Ecology's Environmental Information Management System.

4 Data Generation and Acquisition

This section describes the collection and handling of sediment samples for chemical analyses. Elements include sampling design; sampling methods; sample handling and custody requirements; analytical methods; QA/QC, instrument/equipment testing and frequency, inspection and maintenance; instrument calibration; supply inspection/acceptance; and data management.

4.1 Sampling Design

The sampling design was developed to meet the project objectives presented in Section 2.1. The preliminary design for the habitat restoration was used to select the upland and sediment sampling depths. Figure 2 shows the existing upland topography and sediment bathymetry of T-25S. The existing OHWM denotes the upland boundary of the East Waterway OU of the Harbor Island Superfund Site. Figure 4 shows the proposed sample locations and the project elevation changes (existing relative to proposed subgrade) based on the preliminary design that is not shifted to account for the potential Sound Transit light rail lines. Material above the proposed subgrade elevation represents the material that will be excavated as part of the restoration project. The proposed grade refers to the final restoration elevation following excavation and backfill of suitable habitat substrate. Cross sections depicting existing, proposed grade, and proposed subgrade elevations are shown in Figures 5a and 5b. Proposed and historical sampling locations along or adjacent to these cross sections are projected at their relative locations and depths for reference. The cross sections also include the approximate elevation of the top of wood debris observed in historical subsurface explorations (see Section 4.1.1 and Appendix C).

4.1.1 Upland Borings

Locations of upland borings were selected to provide spatial representativeness in areas that have not previously been sampled and/or are within areas with potential historical contamination based on historical uses. Upland sampling will consist of borings at 15 locations, including 10 locations within the current proposed design footprint and an additional 5 locations in the area where the stormwater pond will be located or where the restoration may be expanded because of the project shift from the Sound Transit light rail lines (Figure 3). Three locations are within the intertidal area adjacent to the existing piling field. Eleven borings will be advanced 20 feet bgs and sampled for disposal characterization (to excavation elevations) and site COPCs below excavation elevations. Three borings will be advanced 25 feet bgs and sampled for disposal characterization (to excavation elevations), site COPCs below excavation elevations (to 20 feet), and geotechnical parameters (to 25 feet). One boring will be advanced to 75 feet bgs and sampled for disposal characterization (to excavation elevation), site COPCs below excavation elevations (to 20 feet), and geotechnical parameters (to 75 feet). Table 1 provides the sampling design for the upland sampling program, which includes the sample depth intervals, coordinates, sample test parameters, and rationale for each location.

The material in the excavation interval will be composited into one sample per boring and submitted to the laboratory for disposal characterization parameters. The 2-foot depth below the subgrade elevation represents the post-excavation surface interval. A 2-foot interval was selected to be consistent with the subsurface characterization for the East Waterway RI, to align with the Dredged Material Management Program (DMMP) definition of the Z-layer, and to provide enough material to analyze the full suite of SMS parameters plus dioxin/furans. Consecutive 2-foot intervals will be collected to the bottom of the boring for testing or archive (see Table 1). Select locations will also include geotechnical samples at discrete intervals. Section 4.2.1 provides more details on the sampling methods and requirements for the upland boring program.

Wood debris was encountered at depth (greater than 10 feet bgs) in many of the historical borings (Appendix C) likely due to fill placement. The approximate depth of wood debris is depicted in the cross sections (Figures 5a and 5b). Wood debris layers encountered during sampling activities will be noted on the boring log. Sampling intervals may be modified in these instances.

4.1.2 Sediment Cores

Sediment core locations were selected to characterize the sediment characteristics throughout the sediment slope adjacent to T-25S and to characterize the sediment that will be dredged during construction of the restoration project. Table 2 provides the sampling design for the sediment cores, which includes the depth, coordinates, sample test parameters, and rationale for each location.

The preliminary design for the restoration project was used to identify the locations where sediment will be dredged. Cores SC-01 through SC-05 were placed within the piling field, in areas where dredging will be required. In addition, cores SC-06 through SC-09 were placed at the perimeter of the piling field to provide spatial coverage.

The material in the removal interval (existing elevation relative to proposed subgrade elevation) at locations SC-01 through SC-05 will be sampled and composited into one sample per core and submitted to the laboratory for disposal characterization. The 2-foot depth below the subgrade elevation represents the post-dredge surface interval and will be analyzed for SMS parameters and dioxins and furans. Cores SC-06 through SC-09 will be sectioned into 2-foot intervals, with the 0- to 2-foot interval from each core analyzed for SMS parameters and dioxins and furans. A 2-foot interval was selected in accordance with the DMMP definition of the Z-layer and to provide enough material to analyze the full suite of SMS parameters plus dioxin/furans. Consecutive 2-foot intervals will be collected to the bottom of the core and archived. These samples will be analyzed if there are SMS exceedances in the post-dredge surface interval to provide a vertical profile of the contaminants that exceed SMS. Section 4.2.2 provides more details on the sampling methods and requirements for the subsurface sediment samples.

Due to the instability of the pilings, subsurface cores within the piling field will be collected using a remote coring device with a maximum target depth of 6 feet below mudline. Subsurface cores at the perimeter of the piling field will be collected to a target depth of 12 feet below mudline. The target depth may not be feasible due to limiting factors including water depth at the location (vibracorer on remote floating platform) and core refusal.

Historical sediment core logs including summary analytical tables from sampling locations adjacent to T-25S from the East Waterway SRI (Windward and Anchor QEA 2014) are included in Appendix C.

4.2 Sampling Methods

This section describes sampling methods and includes sample identification, station positioning, upland soil and sediment collection and processing, decontamination procedures, and waste disposal. Soil samples will be obtained using sonic boring collection methods. Sediment samples will be obtained using vibracore collection methods.

4.2.1 Upland Soil and Intertidal Bank Borings

Upland borings will be collected using a track-mounted sonic drill rig with a 5- or 6-inch-diameter 5-foot length steel core barrel. Sonic drilling is proposed for this study due to the need to drill through fill material that may contain debris from former structures and operations. A small amount of sample disturbance is inherent to sonic drilling methods when material is extruded from the core barrel into plastic liners using vibration. Sample intervals will be selected at no less than 1-foot increments to maintain precision from potential disturbance during collection.

The 5-foot core barrel will be rinsed clean of soil and decontaminated before each use, including between stations, to eliminate the possibility of cross-contamination. A steel catcher (drill shoe) may be used, if necessary, to retain the soil. The core barrel (with drill shoe as needed) will be attached to the drill rod, and the cutting head will be attached to the core barrel. The drill will be deployed from the rig and lowered down to the soil surface.

The core barrel will be sonically-driven into the soil to the targeted depth and retrieved upon either full penetration of the core tube segment, penetration to specified elevations, or at refusal. The depth of core penetration will be measured and recorded, along with conditions and/or obstructions observed during drilling (e.g., difficult drilling conditions). As part of core retrieval, a casing will be advanced over the core barrel before the core barrel is extracted from the cased hole. The cutting bit (and core catcher, if used) will be removed by the drilling operator. Soil within the core tube will be extruded out of the core barrel and into a disposable plastic liner (sleeve) using a low-frequency sonic vibration (i.e., to minimize sample disturbance). Before proceeding with the next sample interval, a measurement will be taken in the cased sample hole to determine if heaving sands have reoccupied the casing, and to verify the top depth and elevation of the next sample interval. If heaving sands are encountered and the casing is occupied by heave, the driller may not blow out this material using water or any other type of pressurized method but must instead determine the length of the core tube that has been reoccupied and collect that material first before proceeding with the next sampling interval. Water pressure may be maintained in the cased hole prior to and during core extraction to minimize heaving sands from occupying the casing.

Acceptance criteria for upland boring samples are as follows:

- The core segment appears intact without obstruction or blocking.
- The core was advanced to the target depth.
- The material in the core supports design objectives (recovery meets elevation targets).

If sample acceptance criteria are not achieved, the sample is rejected unless modified acceptance criteria are approved by the FC and/or multiple attempts have been made at the sampling location. Substantial buried debris exists at T-25S from former structures and operations and are likely to result in poor recovery for some depth intervals. Poor recovery due to buried debris at the site may result in the adjustment of sample intervals to achieve adequate sample volume while still meeting DQOs. These situations will be evaluated on a case-by-case basis by the FC.

Geotechnical standard penetration tests (SPT) will be conducted at three boring locations at subsurface soil intervals identified in Table 1. Two sample locations will be advanced to a depth of 25 feet bgs and one location will be advanced to 75 feet bgs for the purposes of characterizing geotechnical parameters relevant to the habitat restoration at T-25S. While sample intervals will be given priority for chemistry sampling, SPT tests will be conducted approximately every 5 feet in each boring. SPT tests will not be conducted in the 4-foot layer below the proposed excavation cut to prioritize sample volume for post-excavation surface chemical characterization. After advancing the sonic core barrel (and retrieving the soil for chemistry sampling) to the desired elevation bgs, a 2- or 3-inch outside-diameter, decontaminated split spoon will be advanced into the soil using a 140-pound hammer dropped 18 inches. After retrieving the split spoon sampler, sonic coring for the collection of chemistry parameters will continue until the next SPT interval.

Temporary boreholes will be decommissioned in accordance with state regulations (Chapter 173-160 of the Washington Administrative Code [WAC]). Each borehole will be abandoned by backfilling with bentonite chips.

4.2.1.1 Upland Sample Processing

Upland boring samples will be processed adjacent to the station location. For chemical analyses, the plastic liner for each sampling interval will then be cut lengthwise and opened for processing. Each boring will be continuously examined to develop a lithologic boring log and will be photographed. Physical characteristics of each core will be noted on a soil boring form (Appendix B) and will include color, structure, texture, mineral composition, moisture, and recovery, in accordance with American Society for Testing and Materials International (ASTM) D2488. Field screening will include photoionization detector (PID) monitoring of all sampling intervals.

Additionally, the following parameters will be noted:

- Sample recovery
- Odor (e.g., hydrogen sulfide or petroleum)
- Visual stratification, structure, and texture
- Vegetation and debris (e.g., wood chips or fibers, concrete, or metal debris)
- Biological activity (e.g., detritus, shells, tubes, bioturbation, or live or dead organisms)
- Presence of oil sheen

All samples will be collected using decontaminated stainless steel spoons and bowls. Discrete samples will be collected from specified depth intervals, as outlined in Table 1 and spooned into a clean stainless steel bowl for homogenization. The soil will be mixed until homogeneous in color and texture and then spooned into laboratory-supplied jars for testing. The analytical testing scheme for soil samples is presented in Table 1 and associated handling and storage guidelines in Table 3.

Soil and sediment borings will include analysis for site COPCs and physical analyses as summarized below.

- Excavated soil disposal characterization
  - Total solids
  - Toxicity characteristic leaching procedure (TCLP) metals
  - Total petroleum hydrocarbons (diesel and residual range)
  - Total PCB Aroclors
  - Polycyclic aromatic hydrocarbons
  - Semivolatile organic compounds
  - Aliquot of excess sample volume archived for potential additional analyses
- Sample intervals below excavation depth
  - Total solids
  - Total organic carbon
  - SMS metals
  - Total PCB Aroclors

  - Polycyclic aromatic hydrocarbons
  - Semivolatile organic compounds
  - Dioxin/furans
  - Aliquot of excess sample volume archived for potential additional analyses
- Geotechnical intervals
  - Grain size, moisture content, Atterberg limits, and bulk density will be collected at various SPT intervals at the discretion of field staff.
  - Excess soil volume collected from SPT split spoon samples may be archived for potential additional chemical analyses.

4.2.2 Sediment Coring

This section describes the methods for collecting and processing subsurface sediment cores. Sediment sampling will be conducted at locations shown in Figure 2. All field activities will be performed under the direction of the FC, with EPA oversight as appropriate. The field geologist will lead activities associated with the logging and processing of sediment cores. There may be contingencies during field activities that require modification of the general procedures outlined below. Procedures may be modified at the discretion of the FC after consultation with the PM and the boat operators, if applicable. EPA will be consulted if significant deviations from the sampling design are required (e.g., repositioning of a location, as discussed in Section 4.2.5). All modifications will be recorded in the field logbook and on a protocol modification form (Appendix B).

4.2.2.1 Subsurface Sediment Core Collection

Sediment cores will be collected to targeted depths ranging from 6 to 12 feet below mudline (depending upon the location) or until refusal, whichever is reached first. Cores will be collected with a vibracorer. The vibracorer will be deployed by two methods. For cores T25-SC01 through SC05, the vibracorer will be deployed on a remote floating platform in order to navigate within the pilings. Cores T25-SC06 through T25-SC09 will be collected using a vessel-mounted vibracorer.

The vibracorer consists of a vibrating power head attached to a 6-foot-long (floating platform) or 12-foot-long (vessel-mounted), 3.75-inch-diameter core barrel. Once the sampling platform/vessel is positioned at the target sampling location, the vibracorer and a decontaminated core tube is lowered using a hydraulic winch. The core is penetrated to the targeted depth or until refusal, and then pulled up using the winch. Once on board the vessel, the depth of core penetration is measured and recorded (i.e., the total core length minus the void space within the core). The following data will be recorded on the sediment core collection log (Appendix B):

- Sampling location, time, tide, and depth of water to sediment (as measured by leadline)
- Elevation of location as estimated from MLLW using tide tables
- Location coordinates from differential global positioning system (DGPS)

- Names of field personnel collecting and handling the cores
- Observations made during core collection, including weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Physical description of core tube (e.g., intact, bent, full core-catcher)
- Length and depth intervals of each core section and estimated recovery for each sediment sample as measured from MLLW
- Qualitative notation of apparent resistance of sediment column to coring (how the core drove)
- Any deviation from the approved QAPP

4.2.2.2 On-Deck Core Processing

The sediment core tubes will be inspected for adherence to the following criteria:[1]

- Core was collected to the targeted depth below mudline.
- Core tube is not overfilled.
- Overlying water is present and the surface interval is intact.
- Estimated recovery is greater than 75%, and the core tube appears intact without obstructions or blocking.

If sample acceptance criteria are not achieved in the first core at a sampling location, the sample will be set aside and up to two additional core drives will be advanced at locations within 10 meters of the targeted location. If sample acceptance criteria are not achieved in any of the three cores, oversight personnel will be consulted to discuss whether an alternative location should be sampled. The sampling location may be repositioned at a location greater than 10 meters from the targeted location, following discussions with EPA and Port representatives. If an alternative location is not selected, the core with the greatest sampling depth and recovery will be used.

While the core tube is on deck, the overlying water will be siphoned off, if necessary, using plastic tubing or a similar siphoning device. The vibracore tubes will be cut off near the sediment surface. Cores collected using the vibracorer will be cut into 5-foot sections so they can be transported to the laboratory in a vertical position, if possible, and so they will fit in the refrigeration units at the laboratory until processing. The intact core or core sections will be capped, taped, and labeled with the station ID and "top" and "bottom." The vibracore tubes will be reconstructed during core processing by lining up the labeled sections as appropriate. Core tubes will be sealed to minimize loss of moisture and transported to ARI for subsequent processing, sampling, and logging.

[1] An additional criterion is that the core reaches native sediment, which will be determined after the core is opened.

4.2.2.3 Subsurface Sediment Core Processing

Core tubes will be handled and processed at ARI by Windward and Anchor QEA as soon as possible after they are received. Cores will be handled in a manner consistent with ASTM procedures (ASTM D 4220). Cores that are not processed on the day of collection will be stored upright (if possible) in the ARI refrigerators (i.e., vibracores). Cores may be held for a maximum of 72 hours before processing. Core processing will involve three basic steps: 1) core cutting; 2) observation and logging; and 3) sampling. The field geologist will oversee the sediment core processing activities.

Sediment from the vibracorer will be cut for logging and sampling by removing the core caps and cutting the core tube longitudinally with a circular saw. The core will be split into two halves with decontaminated stainless steel wire core splitters or spatulas. If the core was divided into sections for easier transport, this step will be repeated for each section until the entire core is extracted.

The profile of the accepted core for each location will be visually logged for major and minor contacts (i.e., regions in the core where sediment characteristics noticeably change), as described below. A portable PID will be used to determine the potential presence of VOCs in the core. Photographs of each core will be taken before sampling. The core will be logged by a field geologist or geotechnician and recorded on the sediment core processing log (presented in Appendix B).

Below the dredge material disposal characterization elevation, each core will be sub-sectioned into 2-foot sampling intervals according to the sampling design discussed in Section 4.1 and Table 2, unless a major stratigraphic boundary is present. If a major difference in stratigraphic units is observed, the sample will not be collected at the fixed 2-foot interval, but will instead include only sediments within the same stratigraphic unit. Chemical releases to sediment may have been associated with different historical periods as indicated by the sediment stratigraphy, so it is desirable to separate the chemical analyses for the different units. Two additional samples will be collected for additional geotechnical parameters (grain size, Atterberg limits, bulk density, moisture content) within discrete lithological intervals from select core locations depending on the types of lithology encountered.

The sectioning decision for each core will be made by the field geologist, in consultation with EPA oversight if present at the time the core is sectioned. Sediment descriptions and the interpreted *in situ* depths of each sediment horizon (derived from calculations on the bore log) will be recorded on the sediment core processing log (Appendix B). Data recorded on the core processing logs will include the following:

- Sample recovery
- Physical soil description in accordance with ASTM procedures (ASTM D 2488 and ASTM D 2487 – Unified Soil Classification System) including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide, petroleum)

- Visual stratification, structure, and texture
- Vegetation and debris (e.g., woodchips or fibers, paint chips, concrete, sand blast grit, metal debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen
- PID results for potential presence of VOCs

After a core is logged, sediment from designated sampling intervals in that core will be spooned into stainless steel bowls, homogenized until uniform in color and texture, and placed into pre-cleaned, labeled glass jars for chemical analyses, as specified in Section 4.3.1. Care will be taken not to include sediment that has been in contact with the core sidewalls or caps. Organisms and debris will be removed prior to distribution to sample containers; removed materials will be noted in the field logbooks. All sample containers will be labeled on the outside in indelible ink with the sample ID number, date collected, and analysis to be performed.

Each subsurface sediment sample identified for dredge material disposal characterization will be analyzed for total solids, TCLP metals, PCB Aroclors, PAHs, and SVOCs; an aliquot of excess sample volume from each core will be archived for potential additional analyses. Each subsurface sediment sample identified for chemical analyses (except archived samples) will be analyzed for SMS chemicals (SVOCs, PCB Aroclors, mercury, and other metals) and dioxins and furans using analytical methods presented in Section 4.4. Each subsurface sediment sample (except archived samples) identified for chemical analyses will also be analyzed for total organic carbon (TOC), total solids, and grain size. Additional discrete samples collected for geotechnical parameters may be analyzed for grain size, Atterberg limits, moisture content, and bulk density at the discretion of field staff.

4.2.3 Identification Scheme for all Locations and Samples

Each subsurface sediment core sampling location will be assigned a unique alphanumeric location ID number according to the following method:

- The first four characters of the location ID are "T25" to identify the T-25S project area.
- The next four characters are SC (sediment core) or SB (soil boring) to indicate the type of samples to be collected, followed by a consecutive number identifying the specific location (e.g., SC-01, SB-11).
- The sample ID will consist of the location ID followed by a numerical suffix that indicates which depth horizon the sample came from (i.e., 2-4).
- Example sample nomenclature include:
    - T25-SC01-0-3.4: Subsurface sediment sample collected at a depth interval from 0 to 3.4 feet below mudline at location SC-01

- T25-SB11-11.5-13.5: Upland boring sample collected at a depth interval of 11.5 to 13.5 feet below ground surface at location SB-11

- A field duplicate collected from a sample will be identified by the addition of '50' to the sample number. A duplicate sample of the above subsurface sediment example would be T25-SC51-0-3.4.

Rinsate blank samples will use the overall site identifier followed by "RB" and the collection method. The resulting nomenclature of a rinsate blank for subsurface sediment and upland soil processing would be T25-RB-SC and T25-RB-SB, respectively.

4.2.4 Location Positioning – Upland Boring Locations

Horizontal positioning will be determined in the field by a DGPS based on target coordinates. The horizontal datum will be North American Datum of 1983 (NAD83), Washington State Plane North. Measured geographical coordinates for station positions will be recorded and reported to the nearest 0.01 second. In addition, state plane coordinates will be reported to the nearest foot. The DGPS accuracy is less than 1 meter and generally less than 30 cm, depending on the satellite coverage and the number of data points collected. Anchor QEA may photograph the locations to aid in understanding the sample location.

4.2.5 Location Positioning – Sediment Coring Locations

Target sampling locations will be located using a Trimble NT300D DGPS. The DGPS includes a global positioning system (GPS) receiver unit onboard the sampling vessel and a U.S. Coast Guard (USCG) beacon differential receiver. The GPS unit will receive radio broadcasts of GPS signals from satellites. The USCG beacon receiver will acquire corrections to the GPS signals to produce positioning accuracy to within 1 to 2 meters.

Northing and easting coordinates of the vessel will be updated every second and displayed directly on a computer onboard the vessel. The coordinates will then be processed in real time and stored at the time of sampling using the positioning data management software package. NAD83, Washington State Plane North, will be used for the horizontal datum. The vertical datum will be obtained by measuring the depth from the water surface to the mudline at each sampling location using a leadline. This depth will be corrected for tidal influence after sampling has been completed to obtain the depth of the mudline relative to MLLW. Tidal elevation will be determined by calling the National Ocean Service for data from their automated tide gage located at Pier 54.

To ensure the accuracy of the navigation system, a checkpoint will be located at a known point such as a pier face, dock, piling, or similar structure that is accessible by the sampling vessel. At the beginning and end of each day, the vessel will be stationed at the check point, a GPS position reading will be taken, and the reading will be compared with the known land-survey coordinates. The two position readings should agree, within the limits of survey vessel operational mobility, to within 1 to 2 meters.

4.2.6 Decontamination Procedures

All sediment and soil processing and homogenizing equipment used during sampling (i.e., stainless steel plates, spatulas, bowls, and spoons), will be decontaminated between sampling locations following Puget Sound Estuary Program (PSEP) guidelines (1997) and the following procedures:

1. Pre-wash rinse with tap water or site water.
2. Wash and scrub equipment with a solution of tap water and phosphate-free detergent (Alconox or similar).
3. Rinse with tap water.
4. Rinse three times with distilled water.
5. Cover (no contact) all decontaminated items with aluminum foil.
6. Store in a clean, closed container, for bowls, store inverted on a foil-covered surface for next use.

Any sampling equipment that cannot be cleaned to the satisfaction of the FC and EPA (if present) will not be used for further sampling activities.

4.2.7 Waste Disposal

All disposable sampling materials and personal protective equipment used during sample collection in the field, such as disposable coveralls, gloves, and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal as solid waste. Excess sediment/soil remaining after processing will be placed in 55-gallon drums and stored at a secure location. Drums will be properly labeled, kept closed, and stored separately from other incompatible wastes (e.g., liquid solvents). A composite sample of investigative-derived waste will be collected and chemically analyzed to obtain representative data for disposal profiling.

4.3 Sample Handling and Custody Requirements

This section describes how individual samples will be processed, labeled, tracked, stored, and transported to the laboratory for analysis. In addition, this section describes sample custody procedures and shipping requirements. Sample custody is a critical aspect of environmental investigation. Sample possession and handling must be traceable from the time of sample collection through laboratory analyses until Windward or Anchor QEA authorizes sample disposal.

4.3.1 Sample Handling Procedures

Samples for chemical analyses will be placed in appropriately sized, pre-cleaned, labeled, wide-mouth glass jars and capped with Teflon®-lined lids (Table 3). All sample containers will be filled leaving a minimum of 1 cm of headspace to prevent breakage during transport and storage.

Sample labels will be waterproof and self-adhering. Each sample label will contain the project name, sample ID, preservation technique, type of analysis, date and time of collection, and initials of the person(s) preparing the sample. A completed sample label will be affixed to each sample container. The labels will be covered with clear tape immediately after they have been completed to protect them from being stained or spoiled from water, sediment, or soil.

4.3.2 Sample Custody Procedures

Samples are considered to be in custody if they are: 1) in the custodian's possession or view; 2) retained in a secured place (under lock) with restricted access; or 3) placed in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Custody procedures will be used for all cores and samples throughout the collection, transport, and analytical process. Custody procedures will be initiated during sediment core collection. COC forms will accompany sediment cores when they are delivered by the field crew to the processing area (on site or at ARI), and separate forms will then accompany the processed samples during transfer to ARI personnel at the laboratory. Each person who has custody of the cores or samples will sign the COC form and ensure that the cores or samples are not left unattended unless properly secured. Minimum documentation of core or sample handling and custody will include the following:

- Project name and unique core or sample number
- Core or sample collection date and time
- Any special notations on core or sample characteristics or problems
- Initials of the individual collecting the core or sample
- Date core or sample was sent to the laboratory
- Shipping company name and waybill number, if applicable

The FC will be responsible for all sample tracking and custody procedures for sediment cores in the field. The FC will be responsible for final sample inventory and will maintain sample custody documentation. At the end of each day, and prior to transfer of sediment cores and/or sediment samples to the laboratory, COC entries will be made for all cores and samples. Information on the labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms will accompany all cores and samples. The COC forms for the sediment cores will be signed at the point of transfer from the field to the laboratory, and the COC forms for the sediment samples will be signed at the point of transfer from Windward and Anchor QEA personnel to ARI personnel. Copies of all COC forms will be retained and included as appendices to QA/QC reports and data reports. After sediment core processing, the sediment samples will be hand-delivered to ARI. The FC will ensure that the laboratory has accepted delivery of the shipment at the specified time.

The laboratories will ensure that COC forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the COC forms. The laboratories will contact the FC or the project QA/QC coordinator immediately if discrepancies between the COC forms and the sample shipment upon receipt are discovered.

At each laboratory, a unique sample identifier will be assigned to each sample. The laboratory will ensure that a sample tracking record follows each sample through all stages of laboratory processing. The sample tracking record must contain, at a minimum, the name/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed. The laboratories will not dispose of the environmental samples for this project until notified in writing by the project QA/QC coordinator.

4.3.3 Sample Transport and Storage

Sample processing of upland boring locations will be conducted on site. Sample processing of subsurface sediment cores will be conducted on site or at ARI. Samples will be packed securely in bubble wrap and stored on ice or refrigerated until they are directly transferred to the custody of ARI. The temperature inside the cooler(s) containing sediment samples will be checked upon receipt at the laboratory by either measuring the temperature of blank water samples packed inside the cooler, or using an infrared device. The laboratory will specifically note if the cooler is not sufficiently cold (4° ± 2°C) upon receipt.

4.4 Analytical Methods and Data Quality Indicators

This section discusses the analytical methods that will be used to characterize samples and the data quality indicators (DQIs) for each chemical analysis.

4.4.1 Analytical Methods

ARI, a National Environmental Laboratory Accreditation Program accredited laboratory, will conduct physical and chemical testing. Table 4 presents the proposed analytes, evaluation criteria, analytical methods to be used, and target quantitation limits for the evaluation of soil and sediment. All sample analyses will be conducted in accordance with PSEP- and Ecology-approved methods. Prior to analyses, all samples will be maintained according to appropriate holding times and temperatures for each analysis (Table 3).

4.4.2 *Data Quality Indicators*

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Table 5 lists specific DQIs for the laboratory analyses of all samples. These parameters are discussed in greater detail in the following sections.

4.4.2.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample and is expressed as an RPD when duplicate analyses are performed and as %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed through laboratory duplicate analyses (i.e., laboratory replicate samples, MS/MSD, LCS duplicates) for all parameters except when reference materials are not available or spiking of the matrix is inappropriate. In these cases, precision is assessed through laboratory triplicate analyses. Precision measurements can be affected by the nearness of a chemical concentration to the MDL, where the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Table 5). The equations used to express precision are as follows:

Equation 1

$$\mathrm{RPD} = \frac{(\text{measured conc} - \text{measured duplicate conc})}{(\text{measured conc} + \text{measured duplicate conc}) \div 2} \times 100$$

$$\%\mathrm{RSD} = (\mathrm{SD}/\mathrm{D}_{ave}) \times 100$$

where:

$$\mathrm{SD} = \sqrt{\left(\frac{\left(\sum \mathrm{Dn} - \mathrm{D}_{ave}\right)^2}{(n-1)}\right)}$$

D	=	sample concentration
D_{ave}	=	average sample concentration
n	=	number of samples
SD	=	standard deviation

4.4.2.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage recovery for MS, LCS, and ongoing precision and accuracy sample analyses. The DQI for accuracy varies, depending on the analyte (Table 5). The equation used to express accuracy for spiked samples is as follows:

Equation 2

$$\text{Percent recovery} = \frac{\text{spike sample result} - \text{unspiked sample result}}{\text{amount of spike added}} \times 100$$

4.4.2.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific objectives described in Section 2.1. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

4.4.2.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. Sample collection and chemical and physical testing will adhere to the most recent PSEP QA/QC procedures (PSEP 1997) and EPA and PSEP analysis protocols.

4.4.2.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

Equation 3

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100$$

The DQI for completeness for all components of this project is 95%. Data that have been qualified as estimated because the QC criteria have not been met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

4.4.2.6 Sensitivity

Analytical sensitivity is a measure of both the ability of the analytical method to detect the analyte and the concentration that can be reliably quantified. The minimum concentration of the analyte that can be detected is the MDL. The minimum concentration that can be reliably quantified is the QL. Laboratories use both MDLs and QLs for reporting analyte concentrations, and both values will be used as measures of sensitivity for each analysis.

The MDL is defined as the lowest concentration of an analyte or compound that a method can detect in either a sample or a blank with 99% confidence. ARI determines MDLs using standard procedures outlined in 40 CFR 136, in which seven or more replicate samples are fortified at 1 to 5 times (but not to exceed 10 times) the expected MDL concentration. The MDL is then determined by calculating the standard deviation of the replicates and multiplying by the Student's t-factor (e.g., 3.14 for seven replicates).

QLs are equal to or greater than the lower calibration limit defined by the lowest concentration on the calibration curve. QLs, MDLs, and estimated detection limits are adjusted for each sample based on the amount of sample extracted, dilution factors, and percent moisture.

All laboratories will report detected concentrations above the QL without qualification and will report detected concentrations between the MDL (ARI) or estimated detection limit (for dioxins/furans analysis) and the QL with a J-qualifier indicating the concentration is an estimated value. The estimated detection limit for dioxin/furans analysis is a sample-specific detection limit based on the signal to noise ratio at the time of sampling. Non-detect results will be reported to the QL with a U-qualifier.

4.5 Quality Assurance/Quality Control

The QA/QC criteria for the field and laboratory analyses are described below. Table 6 summarizes field and laboratory QA/QC types and frequencies for each analyte.

4.5.1 Field QC Samples

Field duplicate samples will be collected to evaluate the variability attributable to sample homogenization and subsequent sample handling. Field duplicate samples will be collected from the same homogenized material as the original sample and analyzed as a separate sample; this type of field QA/QC sample is also referred to as a field split sample (PSEP 1997). A minimum of one field duplicate sample will be analyzed for every 20 samples.

In addition, a single rinsate blank sample will be collected for each program (in-water and upland) by rinsing laboratory distilled water over the sample homogenization equipment. The rinsate blank sample will be analyzed for the full suite of chemical analyses for each program.

Although data validation guidelines have not been established for field QC samples, the data resulting from the analyses of these samples will be useful in identifying possible problems resulting from sample collection or sample processing in the field. All field QC samples will be documented on the field log and verified by the project QA/QC coordinator or a designee.

4.5.2 Chemical Analysis QC Criteria

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate MDLs for each analyte in each matrix type, and establish an initial calibration curve for all analytes. The laboratory must demonstrate their continued proficiency through participation in inter-laboratory comparison studies and through repeated analyses of SRMs, calibration checks, method blanks, and spiked samples.

4.5.2.1 Sample Delivery Group

Project- and/or method-specific QC measures such as MS/MSD or laboratory replicate samples will be analyzed per sample delivery group (SDG), preparatory batch, or analytical batch, as specified in Table 5. An SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a 2-week period. Although an SDG may span 2 weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

4.5.2.2 Laboratory QC Criteria

The laboratory analysts will review the results of QC analyses of each analytical batch (described below) immediately after the samples have been analyzed. The QC sample results will be evaluated to determine whether control limits have been exceeded. If control limits are exceeded, then appropriate corrective action must be initiated before a subsequent group of samples can be processed (e.g., recalibration followed by reprocessing of the affected samples). The project QA/QC coordinator must be contacted immediately by the laboratory PM if satisfactory corrective action to achieve the DQIs outlined in this QAPP is not possible. All laboratory corrective action reports relevant to the analysis of project samples must be included in the data deliverable packages.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology, Environmental Resource Associates, National Research Council of Canada, or other documented, reliable commercial sources. The accuracy of the standards should be verified through comparison with an independent standard. Laboratory QC standards are verified a multitude of ways. Second-source calibration verification (i.e., same chemicals manufactured by two different vendors) are analyzed to verify initial calibrations. New working standard mixes (e.g., calibrations, spikes) should be verified against the results of the original solution before being put into use and be within 10% of the true value. Newly purchased standards should be verified against current data. Any impurities found in the standard must be documented.

The following subsections summarize the procedures that will be used to assess data quality throughout sample analysis.

Laboratory Replicate Samples

Laboratory replicate samples provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory replicates are subsamples of the original sample that are prepared and analyzed as a separate sample, assuming sufficient sample matrix is available. A minimum of one laboratory replicate sample will be analyzed for each SDG or for every 20 samples, whichever is more frequent, for inorganic and conventional parameters.

Matrix Spikes and Matrix Spike Duplicates

The analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. Through the performance of MSD analyses, information on the precision of the method is also provided for organic analyses. For organic analyses, a minimum of one MS/MSD pair will be analyzed for each SDG, when sufficient sample volume is available. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample volume is available. MS/MSD samples are not performed for dioxin/furan analyses.

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for each extraction/digestion batch or for every 20 samples, whichever is more frequent.

Standard Reference Material

SRMs are samples of similar matrix and of known analyte concentration that are processed through the entire analytical procedure and used as an indicator of method accuracy. A minimum of one SRM will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values, with the exception of the isotope dilution corrections that are required elements of the dioxin analysis (EPA 1613).

Laboratory Control Samples

LCSs are prepared from a clean matrix similar to the project samples and are spiked with known amounts of the target compounds. The recoveries of the compounds are used as a measure of the accuracy of the test methods. LCS recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Internal Standard Spikes

Internal standard spikes may be used for calibrating and quantifying organic compounds and metals by means of inductively coupled plasma-mass spectrometry (ICP-MS). If internal standards are used, all calibration, QC, and project samples will be spiked with the same concentration of the selected internal standard(s). Internal standard recoveries and retention times must be within method and/or laboratory criteria.

4.6 Instrument/Equipment Testing, Inspection, and Maintenance

Prior to each field event, measures will be taken to test, inspect, and maintain all field equipment. All equipment used, including the GPS unit and digital camera will be tested for use before leaving for the field event.

The FC will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory PM will be responsible for ensuring that laboratory equipment testing, inspection, and maintenance requirements are met. The methods used in calibrating the analytical instrumentation are described in the following section.

4.7 Instrument/Equipment Calibration and Frequency

Multipoint initial calibrations will be performed on each instrument prior to sample analysis, after each major interruption to the analytical instrument, and when more than one continuing calibration verification sample does not meet the specified criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration verifications will be performed daily for organic analyses, once every 10 samples for the inorganic analyses and with every sample batch for conventional parameters to ensure proper instrument performance.

The field PID will be calibrated daily per the instructions in the instrument instruction manual.

4.8 Inspection/Acceptance of Supplies and Consumables

The field team leaders for each sampling event will have a checklist of supplies required for each day in the field (see Section 3.2.5). The FC will gather and check these supplies daily for satisfactory conditions before each field event. Batteries used in the GPS unit and digital camera will be checked daily and recharged as necessary. Supplies and consumables for field sampling will be inspected upon delivery and accepted if the condition of the supplies is satisfactory. For example, jars will be inspected to ensure that they are the correct size and quantity and have not been damaged in shipment.

4.9 Data Management

All field data will be recorded on field forms (see Appendix B), which will be checked for missing information by the FC at the end of each field day and amended as necessary. After sampling has been completed, all data from field forms will be scanned and entered into a Microsoft Excel® spreadsheet for import into the project database. A secondary QC check will be done to ensure that 100% of the data were properly transferred from the field forms to the spreadsheet. The scanned field forms and spreadsheet will be kept in the project folder on a secured network, which is backed up daily. All photographs will be transferred to the project folder at the end of the sampling effort.

Analytical laboratories are expected to submit data in an electronic format as described in Section 3.3.3. The laboratory PM will contact the project QA/QC coordinator prior to data delivery to discuss specific format requirements. All laboratory data will be stored in a secured EQuIS database.

5 Assessment and Oversight

5.1 Compliance Assessments and Response Actions

EPA or their designees may observe field activities during each sampling event, as needed. If situations arise in which there is an inability to follow QAPP methods precisely, the PM will determine the appropriate actions or consult EPA if the issue is significant.

5.1.1 Compliance Assessments

Laboratory and field performance assessments consist of on-site EPA reviews of sampling procedures, QA systems, adherence to the QAPP, and equipment for sampling, calibration, and measurement. EPA personnel may conduct a laboratory audit prior to sample analysis. Any pertinent laboratory audit reports will be made available to the project QA/QC coordinator upon request. Analytical laboratories are required to have written procedures to address internal QA/QC; these procedures will be submitted to the project QA/QC coordinator for review to ensure compliance with the QAPP. All laboratories and QA/QC coordinators are required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

5.1.2 Response Actions for Field Sampling

The FC, or a designee, will be responsible for correcting equipment malfunctions throughout field sampling and for resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms will be completed.

5.1.3 Corrective Action for Laboratory Analyses

Analytical laboratories are required to comply with their current written standard operating procedures (SOPs), laboratory QA plan, and analytical methods. Laboratory personnel will identify and correct any anomalies before continuing with sample analysis and will be responsible for reporting problems that may compromise the quality of the data. The laboratory PMs will be responsible for ensuring that appropriate corrective actions are initiated, as required, for conformance with this QAPP.

The project QA/QC coordinator will be notified immediately if any QC parameter exceeds the project DQIs outlined in this QAPP (Table 5) and cannot be resolved through standard corrective action procedures. A description of the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package and described in the case narrative or corrective action form.

5.2 Reports to Management

The PM will update the Port and EPA regarding the status of field sampling activities following the sampling event. The project QA/QC coordinator will also update the Port and EPA after the sampling is completed and samples have been submitted for analyses, when information is received from the laboratory, and when analyses are complete. The status of the samples and analyses will be indicated with emphasis on any deviations from the QAPP. A data report will be prepared after validated data are available, as described in Section 3.3.4.

6 Data Validation and Usability

6.1 Data Validation

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of data quality. A Stage 2B data quality review will be performed for all testing parameters except dioxin/furans which will undergo a Stage 4 validation. Data quality review will be completed by Laboratory Data Consultants in accordance with EPA National Functional Guidelines (EPA 2014, 2017a, 2017b) by considering the following:

- Data completeness
- Holding times
- Method blanks
- Surrogate recoveries
- Detection limits
- Laboratory control samples
- Replicates
- MS/MSD samples
- Initial and continuing calibrations
- Internal Standard area recoveries
- SRM data
- Compound quantitations (Stage 4 only)

Data will be validated in accordance with the DQIs (Table 6), analytical method criteria, and the laboratory's internal performance standards based on its SOPs. The results of the data quality review, including assigning qualifiers in accordance with the EPA National Functional Guidelines (EPA 2014, 2017a, 2017b) and a tabular summary of qualifiers, will be generated by the database manager and submitted to the QA/QC Manager for final review and confirmation of data validity.

Laboratory data, which will be electronically provided and loaded into Anchor QEA's project database, will undergo a 5% check against the laboratory hard copy data. Data will be validated or reviewed manually, and qualifiers, if assigned, will be entered manually. The accuracy of all manually entered data will be verified by a second party. Data tables and reports will be exported from EQuIS to Excel tables.

Field datasheets will be checked for completeness and accuracy prior to delivery to the database manager. Data generated in the field will be documented on hard copy and provided to the database manager, who is responsible for data entry into the database. Manually entered data will be checked by a second party. Field documentation will be filed in the main project file after data entry and checking are complete.

6.2 Reconciliation with Data Quality Objectives

The data quality assessment will be conducted by the project QA/QC coordinator. The results of the third-party independent review and validation will be reviewed, and cases where the project's DQOs were not met will be identified. The usability of the data depends on a variety of factors and will be determined in terms of the magnitude of the DQO exceedance. The QA/QC coordinator will consult the data user to provide a context-specific evaluation of the impact of qualified data on its use.

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Tables

Table 1
Upland Sampling Design

Location ID	Easting	Northing	Existing Elevation (ft MLLW)	Design Subgrade Elevation (ft MLLW)	Estimated Excavation depth (ft bgs)	Sample Interval[a, b] (ft bgs)	Sample Analysis	Location Rationale	Relevant DQO
SB-01	1267861	212685	16.1	6.2	9.9	0 - 10	Excavation Material[c]	Located within footprint of former cold storage facility, data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						10 - 12	Full Suite[d]		
						12 - 14	Archive		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		
SB-02	1267649	212490	12.0	9.3	2.7	0 - 1.5	Excavation Material[c]	Spatial coverage of shoreline within treated wood piling area. Geotechnical evaluation to include static stability for areas along the shoreline.	Disposal characterization, characterize post-excavation surface, geotechnical
						1.5 - 3	SPT[e]		
						3 - 5	Full Suite[d]		
						5 - 7	Archive		
						7 - 8.5	SPT[e]		
						8.5 - 10.5	Archive		
						10.5 - 12.5	Archive		
						12.5 - 14	SPT[e]		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 19.5	SPT[e]		
						19.5 - 23.5	Observation Only[b]		
						23.5 - 25	SPT[e]		
SB-03	1267739	212415	15.6	8.0	7.6	0 - 7.5	Excavation Material[c]	Located within the former footprint of the sawmill and adjacent to an underground storage tank removal and soil excavation area for hydrocarbon contamination (Sweet-Edwards 1990). Geotechnical evaluation to include static and seismic stability for areas receiving considerable excavation.	Disposal characterization, characterize post-excavation surface, geotechnical
						1.5 - 3	SPT[e]		
						6 - 7.5	SPT[e]		
						7.5 - 9.5	Full Suite[d]		
						9.5 - 11.5	Archive		
						11.5 - 13	SPT[e]		
						13 - 15	Archive		
						15 - 17	Archive		
						17 - 18.5	SPT[e]		
						18.5 - 20.5	Archive		
						20.5 - 23.5	Observation Only[b]		
						23.5 - 25	SPT[e]		
						25 - 75[g]	SPT[e,f]		

Table 1
Upland Sampling Design

Location ID	Easting	Northing	Existing Elevation (ft MLLW)	Design Subgrade Elevation (ft MLLW)	Estimated Excavation depth (ft bgs)	Sample Interval[a, b] (ft bgs)	Sample Analysis	Location Rationale	Relevant DQO
SB-04	1267508	212256	16.6	5.8	10.8	0 - 11.0	Excavation Material[c]	Spatial coverage of far southwest area of Site adjacent to a former maintenance building, mill boiler, and sawmill. Geotechnical evaluation to include static stability in areas of considerable excavation.	Disposal characterization, characterize post-excavation surface, geotechnical
						3.5 - 5	SPT[e]		
						9.5 - 11.0	SPT[e]		
						11.0 - 13.0	Full Suite[d]		
						13.0 - 15.0	Archive		
						15.0 - 16.5	SPT[e]		
						16.5 - 18.5	Archive		
						18.5 - 20.5	Archive		
						20.5 - 23.5	Observation Only[b]		
						23.5 - 25.0	SPT[e]		
SB-05	1267693	212719	10.6	6.9	3.7	0 - 4	Excavation Material[c]	Intertidal bank location in northern edge of property adjacent to the footprint of the former Cold Storage Facility and within treated wood piling area. Previous surface sediment sampling in the intertidal bank area reported SMS exceedances of pentachlorophenol and PAHs (Anchor QEA 2012).	Disposal characterization, characterize post-excavation surface
						4 - 6	Full Suite[d]		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 12	Archive		
						12 - 14	Archive		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		
SB-06	1267667	212608	10.2	10.0	0.2	0 - 2	Full Suite[d]	Intertidal bank location adjacent to the footprint of the former Cold Storage Facility and within treated wood piling area. Previous surface sediment sampling in the intertidal bank area reported SMS exceedances of pentachlorophenol and PAHs (Anchor QEA 2012).	Disposal characterization, characterize post-excavation surface
						2 - 4	Archive		
						4 - 6	Archive		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 12	Archive		
						12 - 14	Archive		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		

Table 1
Upland Sampling Design

Location ID	Easting	Northing	Existing Elevation (ft MLLW)	Design Subgrade Elevation (ft MLLW)	Estimated Excavation depth (ft bgs)	Sample Interval[a, b] (ft bgs)	Sample Analysis	Location Rationale	Relevant DQO
SB-07	1267849	212476	15.2	7.1	8.1	0 - 8	Excavation Material[e]	Located of former compressor building, automobile preparation, and automobile undercoating facilities. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						8 - 10	Full Suite[d]		
						10 - 12	Archive		
						12 - 14	Archive		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		
SB-08	1267534	212430	16.4	4.1	12.4	0 - 12	Excavation Material[c]	Shoreline sampling location in southwest portion of property receiving considerable excavation. Adjacent to the former Maintainance Building footprint.	Disposal characterization, characterize post-excavation surface
						12 - 14	Full Suite[d]		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		
SB-09	1267665	212373	14.7	7.1	7.6	0 - 8	Excavation Material[c]	Located within the western extent of former sawmill and adjacent to former machine and workshop structures. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						8 - 10	Full Suite[d]		
						10 - 12	Archive		
						12 - 14	Archive		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		
SB-10	1267919	212294	16.5	13.5[g]	3.0[g]	0 - 2	Full Suite[d, i]	Located adjacent to the former sawmill along the southern extent of the project area. Near historical location B-10, which had elevated levels of PAHs and petroleum odors approximately 10 feet bgs (Blymyer 1989).	Disposal characterization, characterize post-excavation surface
						2 - 4	Archive		
						4 - 6	Archive		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 12	Archive		
						12 - 14	Archive		
						14 - 16	Archive		
						16 - 18	Archive		
						18 - 20	Archive		

Table 1
Upland Sampling Design

Location ID	Easting	Northing	Existing Elevation (ft MLLW)	Design Subgrade Elevation (ft MLLW)	Estimated Excavation depth (ft bgs)	Sample Interval[a, b] (ft bgs)	Sample Analysis	Location Rationale	Relevant DQO
SB-11	1267638	212231	17.1	8.7	8.5	0 - 9	Excavation Material[c]	Spatial coverage of southern boundary of Site near former transformer area. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						9 - 11	Full Suite[d]		
						11 - 13	Archive		
						13 - 15	Archive		
						15 - 17	Archive		
						17 - 19	Archive		
						19 - 20	Archive		
SB-12	1267984	212687	16.4	15.4[h]	1.0[h]	0 - 2	Full Suite[d, i]	Located within footprint of former cold storage facility and along a proposed bike trail and stormwater pond area. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						2 - 4	Archive		
						4 - 6	Archive		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 20	Observation Only[b]		
SB-13	1267984	212440	15.0	14.0[h]	1.0[h]	0 - 2	Full Suite[d, i]	Located adjacent the former Sawmill along a proposed bike trail and stormwater pond area. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						2 - 4	Archive		
						4 - 6	Archive		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 20	Observation Only[b]		
SB-14	1268160	212610	16.4	15.4[h]	1.0[h]	0 - 2	Full Suite[d, i]	Located within footprint of former cold storage facility and along eastern edge of the project boundary. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						2 - 4	Archive		
						4 - 6	Archive		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 20	Observation Only[b]		
SB-15	1268106	212395	15.0	14.0[h]	1.0[h]	0 - 2	Full Suite[d, i]	Located within the footprint of the former Sawmill and automobile preparation buildings. Data gap area with no historical data.	Disposal characterization, characterize post-excavation surface
						2 - 4	Archive		
						4 - 6	Archive		
						6 - 8	Archive		
						8 - 10	Archive		
						10 - 20	Observation Only[b]		

Table 1
Upland Sampling Design

Location ID	Easting	Northing	Existing Elevation (ft MLLW)	Design Subgrade Elevation (ft MLLW)	Estimated Excavation depth (ft bgs)	Sample Interval[a, b] (ft bgs)	Sample Analysis	Location Rationale	Relevant DQO

Notes:

Coordinates are in NAD83 WA State Plane North, U.S. Feet.

a. Sample intervals may be adjusted due to anthropogenic debris encountered during sampling.

b. Discrete samples will be collected within lithological layers with visual indicators of contamination (sheen), odors, or elevated PID readings relative to ambient conditions.

c. Sample collected for characterization of excavated soils including TPH-Dx, TCLP metals, SVOCs, PAHs, PCBs, TS

d. Full upland chemical suite includes: grain size, TS/TOC, metals, SVOCs, PAHs, Total PCB Aroclors, D/Fs

e. Proposed SPT sample interval is approximate and may be adjusted to prioritize chemistry sampling. A subset of SPT samples collected with a split-spoon sampler will be analyzed for atterberg limits, grain size, moisture content, and bulk density as determined by field staff. Excess sample volume will be included in the associated excavattion material sample interval or archived (deeper intervals).

f. SPT samples will be collected every 5 ft to an approximate depth of 75 ft bgs, methods will conform to ASTM D 1586

g. Design elevations are not available for this location; an excavation depth of 3 feet is assumed.

h. Design elevations are not available for this location; an excavation depth of 1 foot is assumed.

i. Sample interval will also be run for TCLP metals for potential disposal characterization

bgs: below ground surface

D/F: dioxin/furans

DQO: data quality objective

ID: identification

ft: feet

MLLW: mean lower low water

NAD83: North American Datum of 1983

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

PID: photoionization detector

SMS: sediment management standards

SPT: standard penetration test

SVOC: semi-volatile organic compounds

TCLP: toxicity characteristic leaching procedure

TOC: total organic carbon

TPH: total petroleum hydrocarbons

TS: total solids

TVS: total volatile solids

Table 2
Sediment Sampling Design

Location ID	Easting	Northing	Existing Elevation (ft MLLW)	Design Subgrade Elevation (ft MLLW)	Estimated Dredge Depth (ft)	Sample Interval[a] (ft)	Sample Analysis[a]	Location Rationale: Dredging location?	Location Rationale: Within Piling Field?	Location Rationale: Relevant DQO
SC-01	1267799	212813	6.0	2.6	3.4	0 - 3.4	Dredge Material[b]	yes	yes	Disposal characterization, characterize post-dredge surface
						3.4 - 5.4	Full Suite[c]			
						Additional 2 ft to bottom of core	Archive			
SC-02	1267703	212810	6.0	-1.5	7.6	0 - 7.6	Dredge Material[b]	yes	yes	Disposal characterization, characterize post-dredge surface
						7.6 - 9.6	Full Suite[c]			
						Additional 2 ft to bottom of core	Archive			
SC-03	1267677	212749	6.2	-0.1	6.3	0 - 6.3	Dredge Material[b]	yes	yes	Disposal characterization, characterize post-dredge surface
						6.3 - 8.3	Full Suite[c]			
						Additional 2 ft to bottom of core	Archive			
SC-04	1267622	212597	6.2	0.7	5.6	0 - 5.6	Dredge Material[b]	yes	yes	Disposal characterization, characterize post-dredge surface
						5.6 - 7.6	Full Suite[c]			
						Additional 2 ft to bottom of core	Archive			
SC-05	1267396	212371	2.5	-4.8	7.3	0 - 7.3	Dredge Material[b]	yes	yes	Disposal characterization, characterize post-dredge surface
						7.3 - 9.3	Full Suite[c]			
						Additional 2 ft to bottom of core	Archive			
SC-06	1267525	212523	-9.3	--[d]	--[d]	0 - 2	Full Suite[c]	no	outer edge	Spatial characterization
						Additional 2 ft to bottom of core	Archive			
SC-07	1267578	212705	-23.0	--[d]	--[d]	0 - 2	Full Suite[c]	no	outer edge	Spatial characterization
						Additional 2 ft to bottom of core	Archive			
SC-08	1267625	212874	-26.4	--[d]	--[d]	0 - 2	Full Suite[c]	no	outer edge	Spatial characterization
						Additional 2 ft to bottom of core	Archive			
SC-09	1267734	212901	-34.2	--[d]	--[d]	0 - 2	Full Suite[c]	no	outer edge	Spatial characterization
						Additional 2 ft to bottom of core	Archive			

Notes:
Coordinates are in NAD83 WA State Plane North, U.S. Feet.
a. Additional samples for grain size, atterberg limits, moisture content, and specific gravity will be collected within discrete lithological layers from select locations to inform the geotechnical program.
b. Sample collected for characterization of dredged sediments includes TCLP metals, SVOCs, PAHs, PCBs, and TS.
c. Full Sediment chemical suite includes: grain size, TS/TOC, metals, SVOCs, PAHs, Total PCB Aroclors, and dioxins/furans.
d. Location is outside of proposed dredge area.
DQO: data quality objective
ft: feet
MLLW: mean lower low water
NAD83: North American Datum of 1983
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
SVOC: semivolatile organic carbon
TCLP: toxicity characteristic leaching procedure
TOC: total organic carbon
TS: total solids

Table 3
Guidelines for Sample Handling and Storage

<table>
<tr><th>Parameter</th><th>Sample Size</th><th>Container Size and Type[a]</th><th>Holding Time</th><th>Preservative</th></tr>
<tr><td colspan="5">Soil and Sediment</td></tr>
<tr><td rowspan="2">Total metals</td><td rowspan="2">100 g</td><td rowspan="2">4-oz Glass</td><td>6 months; 28 days for mercury</td><td>4° C ± 2° C</td></tr>
<tr><td>2 years; 28 days for mercury</td><td>-18° C ± 2° C</td></tr>
<tr><td rowspan="3">SVOCs/PAHs, PCBs</td><td rowspan="5">750 g</td><td rowspan="5">2 x 16-oz Glass</td><td>14 days until extraction</td><td>4° C ± 2° C</td></tr>
<tr><td>1 year until extraction</td><td>-18° C ± 2° C</td></tr>
<tr><td>40 days after extraction</td><td>4° C ± 2° C</td></tr>
<tr><td rowspan="2">TPH-Dx (Upland only)</td><td>14 days until extraction</td><td>4° C ± 2° C</td></tr>
<tr><td>40 days after extraction</td><td>4° C ± 2° C</td></tr>
<tr><td>Dioxins/furans</td><td>100 g</td><td>8-oz Amber Glass</td><td>1 year until extraction</td><td>4° C ± 2° C or -18° C ± 2° C</td></tr>
<tr><td>Grain size</td><td>500 g</td><td>16-oz Glass, HDPE, or plastic bag</td><td>6 months</td><td>4° C ± 2° C</td></tr>
<tr><td rowspan="2">Total solids/total organic carbon</td><td rowspan="2">375 g</td><td rowspan="2">8-oz Glass or HDPE</td><td>14 days</td><td>4° C ± 2° C</td></tr>
<tr><td>6 months</td><td>-18° C ± 2° C</td></tr>
<tr><td>Chemistry archive</td><td>500 g</td><td>16-oz Glass</td><td>1 year until extraction</td><td>Freeze/-18° C</td></tr>
<tr><td>Atterberg Limits</td><td rowspan="2">500 g</td><td rowspan="2">16-oz Glass, HDPE, or plastic bag</td><td rowspan="3">6 months</td><td rowspan="3">Cool/4° C</td></tr>
<tr><td>Moisture Content</td></tr>
<tr><td>Bulk Density (Upland only)</td><td>--</td><td>3-inch diameter Shelby Tube
or 16-oz Glass</td></tr>
</table>

Table 3
Guidelines for Sample Handling and Storage

Parameter	Sample Size	Container Size and Type[a]	Holding Time	Preservative
Rinsate Blanks				
Total Metals	--	500mL HDPE with HNO_3	6 months; 28 days for mercury	Cool/4° C; HNO_3 to pH<2
SVOCs/PAHs	--	2 x 500mL Amber Glass	7 days until extraction	Cool/4° C
			40 days after extraction	
PCBs	--	2x 500mL Amber Glass	1 year until extraction	Cool/4° C
			40 days after extraction	
TPH-Dx (Upland only)	--	2x 1L Amber Glass	1 year until extraction	Cool/4° C
			40 days after extraction	
Dioxins/furans	--	2x 1L Amber Glass	1 year until extraction	Cool/4° C
			40 days after extraction	

Notes:

a. All sample containers will have lids with Teflon inserts.

°C: degrees Celsius

g: grams

HDPE: high density polyethylene

L: liter

mL: milliliter

oz: ounces

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

SVOC: semivolatile organic compound

TPH: total petroleum hydrocarbons

Table 4
Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit	SMS Marine Sediment		Marine SMS AET	
			SCO	CSL	SCO	CSL
Conventional Parameters, %						
Total solids	SM2540G/PSEP	0.1	---	---	---	---
Total organic carbon	Plumb, 1981/EPA 9060 Mod	0.1	---	---	---	---
Metals - mg/kg dry weight						
Arsenic	6010C/6020A	5.0	57	93	57	93
Cadmium	6010C/6020A	0.2	5.1	6.7	5.1	6.7
Chromium	6010C/6020A	0.5	260	270	260	270
Copper	6010C/6020A	0.2	390	390	390	390
Lead	6010C/6020A	2.0	450	530	450	530
Mercury	7471B	0.025	0.41	0.59	0.41	0.59
Silver	6010C/6020A	0.3	6.1	6.1	6.1	6.1
Zinc	6010C/6020A	1.0	410	960	410	960
TCLP Metals - µg/L						
Arsenic	1311/6010C	0.250	---	---	---	---
Barium	1311/6010C	0.015	---	---	---	---
Cadmium	1311/6010C	0.010	---	---	---	---
Chromium	1311/6010C	0.025	---	---	---	---
Lead	1311/6010C	0.100	---	---	---	---
Mercury	1311/6010C	0.0001	---	---	---	---
Selenium	1311/6010C	0.250	---	---	---	---
Silver	1311/6010C	0.015	---	---	---	---
Polycyclic Aromatic Hydrocarbons - µg/kg dry weight			**mg/kg OC**		**µg/kg dry weight**	
Naphthalene	8270D	20.0	99	170	2,100	2,100
Acenaphthylene	8270D	20.0	66	66	1,300	1,300
Acenaphthene	8270D	20.0	16	57	500	500
Fluorene	8270D	20.0	23	79	540	540
Phenanthrene	8270D	20.0	100	480	1,500	1,500
Anthracene	8270D	20.0	220	1,200	960	960
2-Methylnaphthalene	8270D	20.0	38	64	670	670
Total LPAH[a]	calculated	---	370	780	5,200	5,200
Fluoranthene	8270D	20.0	160	1,200	1,700	2,500
Pyrene	8270D	20.0	1,000	1,400	2,600	3,300
Benzo(a)anthracene	8270D	20.0	110	270	1,300	1,600
Chrysene	8270D	20.0	110	460	1,400	2,800
Total benzo(b,j,k)fluoranthenes	8270D	40.0	230	450	3,200	3,600
Benzo(a)pyrene	8270D	20.0	99	210	1,600	1,600
Indeno(1,2,3-cd)pyrene	8270D	20.0	34	88	600	690
Dibenz(a,h)anthracene	8270D	5.0	12	33	230	230
Benzo(g,h,i)perylene	8270D	20.0	31	78	670	720
Total HPAHs[b]	calculated	---	960	5,300	12,000	17,000
Chlorinated Hydrocarbons - µg/kg dry weight			**mg/kg OC**		**µg/kg dry weight**	
1,4-Dichlorobenzene	8270D SIM Dual Scan	5.0	3.1	9	110	110
1,2-Dichlorobenzene	8270D SIM Dual Scan	5.0	2.3	2.3	35	50
1,2,4-Trichlorobenzene	8270D SIM Dual Scan	5.0	0.81	1.8	31	51
Hexachlorobenzene (HCB)	8270D SIM Dual Scan	5.0	0.38	2.3	22	70
Hexachlorobutadiene	8270D SIM Dual Scan	5.0	3.9	6.2	11	120

Table 4
Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit	SMS Marine Sediment SCO	SMS Marine Sediment CSL	Marine SMS AET SCO	Marine SMS AET CSL
Phthalates - µg/kg dry weight			**mg/kg OC**		**µg/kg dry weight**	
Dimethyl phthalate	8270D SIM Dual Scan	5.0	53	53	71	160
Diethyl phthalate	8270D SIM Dual Scan	5.0	61	110	200	>1,200
Di-n-butyl phthalate	8270D	20.0	220	1,700	1,400	1,400
Butyl benzyl phthalate	8270D	20.0	4.9	64	63	900
Bis(2-ethylhexyl) phthalate	8270D	50.0	47	78	1300	1900
Di-n-octyl phthalate	8270D	20.0	58	4,500	6,200	6,200
Phenols - µg/kg dry weight						
Phenol	8270D SIM Dual Scan	5.0	420	1,200	420	1,200
2-Methylphenol	8270D SIM Dual Scan	5.0	63	63	63	63
4-Methylphenol	8270D SIM Dual Scan	5.0	670	670	670	670
2,4-Dimethylphenol	8270D SIM Dual Scan	25.0	29	29	29	29
Pentachlorophenol	8270D SIM Dual Scan	20.0	360	690	360	690
Miscellaneous Extractables - µg/kg dry weight			**mg/kg OC (unless noted)**		**µg/kg dry weight**	
Benzyl Alcohol	8270D SIM Dual Scan	20.0	57 dry wt	73 dry wt	57	73
Benzoic Acid	8270D SIM Dual Scan	100.0	650 dry wt	650 dry wt	650	650
Dibenzofuran	8270D	20.0	15	58	540	540
N-Nitrosodiphenylamine	8270D SIM Dual Scan	5.0	11	11	28	40
Polychlorinated Biphenyls - µg/kg dry weight (unless noted)			**mg/kg OC**		**µg/kg dry weight**	
Total Aroclor PCBs	8082	4.0	12	65	130	1,000
Dioxin/Furans - ng/kg dry weight						
Dioxins						
2,3,7,8-TCDD	1613B	1.0	---	---	---	---
1,2,3,7,8-PeCDD	1613B	1.0	---	---	---	---
1,2,3,4,7,8-HxCDD	1613B	2.5	---	---	---	---
1,2,3,6,7,8-HxCDD	1613B	2.5	---	---	---	---
1,2,3,7,8,9-HxCDD	1613B	2.5	---	---	---	---
1,2,3,4,6,7,8-HpCDD	1613B	2.5	---	---	---	---
OCDD	1613B	5.0	---	---	---	---
Furans						
2,3,7,8-TCDF	1613B	1.0	---	---	---	---
1,2,3,7,8-PeCDF	1613B	2.5	---	---	---	---
2,3,4,7,8,-PeCDF	1613B	1.0	---	---	---	---
1,2,3,4,7,8-HxCDF	1613B	2.5	---	---	---	---
1,2,3,6,7,8-HxCDF	1613B	2.5	---	---	---	---
1,2,3,7,8,9-HxCDF	1613B	2.5	---	---	---	---
2,3,4,6,7,8-HxCDF	1613B	2.5	---	---	---	---
1,2,3,4,6,7,8-HpCDF	1613B	2.5	---	---	---	---
1,2,3,4,7,8,9-HpCDF	1613B	2.5	---	---	---	---
OCDF	1613B	5.0	---	---	---	---
Total TEQ	1613B	4.0	---	---	---	---
Bulk Petroleum Hydrocarbons - mg/kg dry weight (Upland Samples Only)						
TPH-Diesel	NWTPH-Dx	50.0	---	---	---	---
TPH-Residual	NWTPH-Dx	100.0	---	---	---	---

Table 4

Parameters for Analysis, Screening Levels, Analytical Methods, and Target Quantitation Limits

Parameter	Analytical Method	Quantitation Limit	SMS Marine Sediment		Marine SMS AET	
			SCO	CSL	SCO	CSL
Geotechnical						
Atterberg limits (%)	ASTM D 4318	0.1	--	--	--	--
Specific gravity	ASTM D 854	0.01	--	--	--	--
Bulk density (g/cc)	ASTM D 2937	0.1	--	--	--	--
Grain size (%)	ASTM D421/422	0.1	--	--	--	--
Moisture content (%)	ASTM D 2216	0.1	--	--	--	--

Notes:

a. Total LPAH consists of the sum of naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.

b. Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.

µg/kg: micrograms per kilogram
µg/L: micrograms per liter
AET: Apparent Effects Threshold
CSL: cleanup screening level
EPA: U.S. Environmental Protection Agency
HPAH: high-density polycyclic aromatic hydrocarbons
LPAH: low-density polycyclic aromatic hydrocarbons
mg/kg: milligrams per kilogram
ng/kg: nanograms per kilogram
OC: organic carbon normalized
OCDD: octachlorodibenzodioxin
OCDF: octachlorodibenzofuran
PCB: polychlorinated biphenyl
PSEP: Puget Sound Estuary Program
SMS: Sediment Management Standards
SCO: sediment cleanup objective
TEQ: toxic equivalency quotient
TPH: total petroleum hydrocarbons

Table 5
Data Quality Indicators

Parameter	Precision (Laboratory Replicates)	Accuracy			Completeness
		Instrument Calibration (% Difference)	Spiked Samples (% Recovery)	Surrogates[a]	
Grain size	± 20% RSD	NA	NA	NA	95%
Total solids	± 20% RSD	NA	NA	NA	95%
Total organic carbon	± 20% RSD	NA	65% – 135% R	NA	95%
Total metals	± 20% RPD	±10	75% – 125% R	NA	95%
SVOCs/PAHs	± 35% RPD	±20	50% – 150% R	Lab limits	95%
TPH	± 35% RPD	±20	50% – 150% R	Lab limits	95%
Dioxin/Furans	± 35% RPD	±25	50% – 150% R	Lab limits	95%
Polychlorinated biphenyls	± 35% RPD	±20	50% – 150% R	Lab limits	95%
Geotechnical Parameters	NA	NA	NA	NA	95%

Notes:

a. Laboratory performance limits are established for each method/analyte.

NA: not applicable

PAH: polycyclic aromatic hydrocarbon

R: recovery

RPD: relative percent difference

RSD: relative standard deviation

SVOC: semivolative organic carbon

TPH: Total petroleum hydrocarbons

TVS: total volatile solids

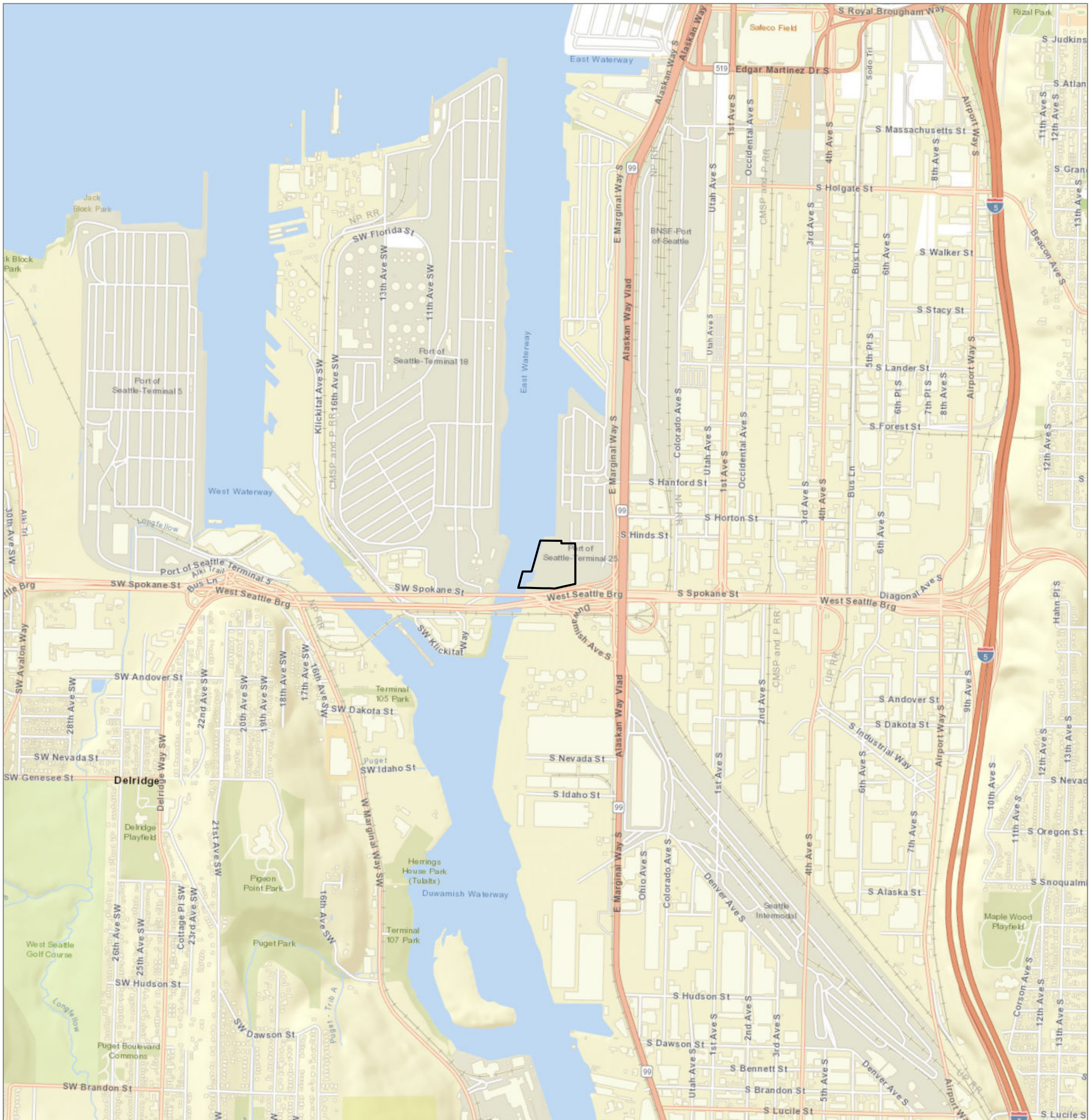
Table 6
Quality Control Sample Analysis Summary

Analysis Type	Field Quality Control Elements		Laboratory Quality Control Elements							
	Field Duplicate	Field/Equipment Blank	Initial Calibration	Ongoing Calibration	Replicates	Laboratory Control Sample or Certified Reference Material[f]	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Grain size	1 per 20 samples	NA	Each batch[a]	NA	Triplicates required per batch	NA	NA	NA	NA	NA
Total solids	1 per 20 samples	NA	Each batch[a]	NA	Triplicates required per batch	NA	NA	NA	NA	NA
Total organic carbon	1 per 20 samples	NA	Daily or each batch	1 per 10 samples	Triplicates required per batch	1 per 20 samples or 1 per batch, whichever is more frequent	NA	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA
Metals	1 per 20 samples	1 per sampling event	Daily	1 per 10 samples	Duplicates required per batch	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA	1 per 20 samples or 1 per batch, whichever is more frequent	NA
SVOCs/PAHs	1 per 20 samples	1 per sampling event	As needed[b]	Every 12 hours[c]	Matrix spike duplicate may be used	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample
TPH	1 per 20 samples	1 per sampling event	As needed[b]	1 per 10 samples[c]	Matrix spike duplicate may be used	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	NA	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample
Dioxin/Furans	1 per 20 samples	1 per sampling event	As needed[b]	Every 12 hours[c]	Duplicates required per batch	1 per 20 samples or 1 per batch, whichever is more frequent	NA	NA	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample[e]
PCBs[d]	1 per 20 samples	1 per sampling event	As needed[b]	1 per 10 samples[c]	Matrix spike duplicate may be used	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	1 per 20 samples or 1 per batch, whichever is more frequent	Every sample

Notes:

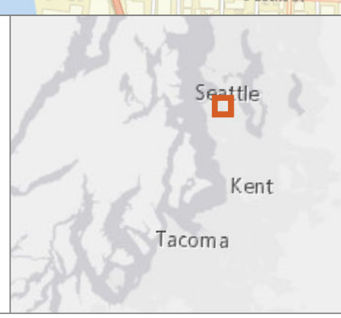
a. Calibration and certification of drying ovens and weighing scales are conducted bi-annually.
b. Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.
c. Ongoing calibrations at the beginning and end of each batch.
d. PCBs will have all detects confirmed via second column confirmation. The second column must be of a dissimilar stationary phase from the primary column and meet all method requirements for acceptance.
e. Isotope dilution with labeled compounds required in every sample.
f. An ongoing precision and recovery (OPR) sample functions as a laboratory control sample to assess the accuracy of the analysis of dioxins/furans. Duplicate OPR samples may be used to assess the precision of the analysis of dioxins/furans.
NA: not applicable
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyls
SVOC: semivolatile organic compounds
TPH: total petroleum hydrocarbons

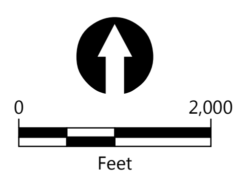
Figures



LEGEND:

☐ Site Location





Publish Date: 2018/05/30, 1:45 PM | User: ckiblinger
Filepath: \\orcas\gis\Jobs\PortofSeattle_0003\SD01_T25_Wetland\Maps\QAPP\AQ_PoS_SD01_T25_VicinityMap_QAPP.mxd

ANCHOR QEA

Figure 1
Vicinity Map
Quality Assurance Project Plan
Port of Seattle Terminal 25 South Design Characterization

SOURCE: Drawing prepared from survey by The Watershed Company. Bathymetry from the Port of Seattle, dated January-March 2018.
HORIZONTAL DATUM: Washington State Plane North, NAD83, U.S. Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND
Existing Contour (2-foot Interval)
Existing OHWM

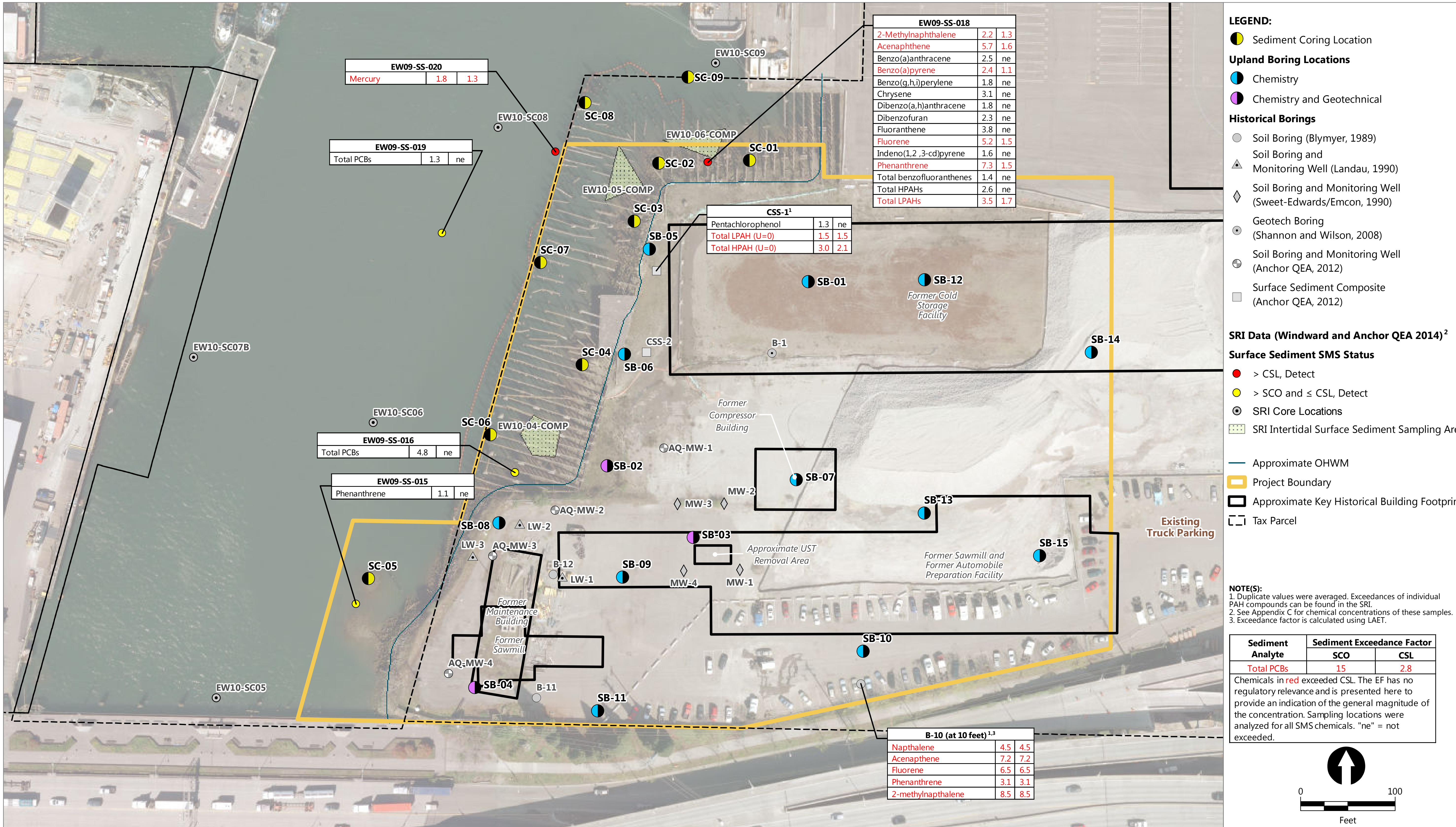
0 80
Feet

Publish Date: 2018/05/30 1:34 PM | User: tgriga
Filepath: K:\Projects\0003-Port of Seattle\POS SD-01 - T-25 Wetland\0003-WK-006 (TWC Design and XS).dwg Figure 2

ANCHOR QEA

Figure 2
Existing Site Topography/Bathymetry

Quality Assurance Project Plan
Port of Seattle Terminal 25 South Design Characterization



EW09-SS-020		
Mercury	1.8	1.3

EW09-SS-019		
Total PCBs	1.3	ne

EW09-SS-016		
Total PCBs	4.8	ne

EW09-SS-015		
Phenanthrene	1.1	ne

EW09-SS-018		
2-Methylnaphthalene	2.2	1.3
Acenaphthene	5.7	1.6
Benzo(a)anthracene	2.5	ne
Benzo(a)pyrene	2.4	1.1
Benzo(g,h,i)perylene	1.8	ne
Chrysene	3.1	ne
Dibenzo(a,h)anthracene	1.8	ne
Dibenzofuran	2.3	ne
Fluoranthene	3.8	ne
Fluorene	5.2	1.5
Indeno(1,2,3-cd)pyrene	1.6	ne
Phenanthrene	7.3	1.5
Total benzofluoranthenes	1.4	ne
Total HPAHs	2.6	ne
Total LPAHs	3.5	1.7

CSS-1[1]		
Pentachlorophenol	1.3	ne
Total LPAH (U=0)	1.5	1.5
Total HPAH (U=0)	3.0	2.1

B-10 (at 10 feet)[1,3]		
Napthalene	4.5	4.5
Acenapthene	7.2	7.2
Fluorene	6.5	6.5
Phenanthrene	3.1	3.1
2-methylnapthalene	8.5	8.5

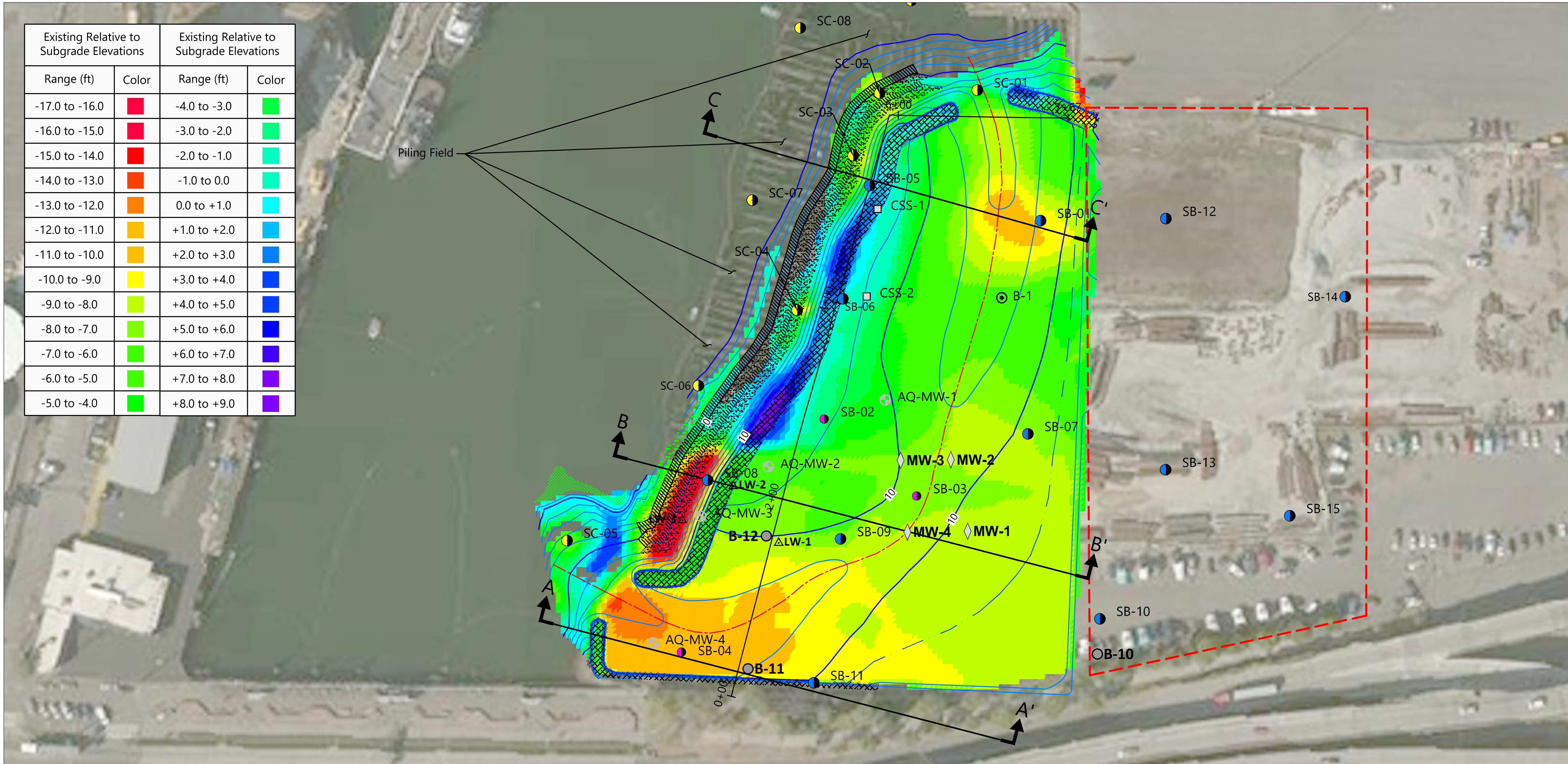
Sediment Analyte	Sediment Exceedance Factor	
	SCO	CSL
Total PCBs	15	2.8

Chemicals in red exceeded CSL. The EF has no regulatory relevance and is presented here to provide an indication of the general magnitude of the concentration. Sampling locations were analyzed for all SMS chemicals. "ne" = not exceeded.

Publish Date: 2018/11/15, 12:49 PM | User: ckiblinger
Filepath: \\orcas\gis\Jobs\PortofSeattle_0003\SD01_T25_Wetland\Maps\QAPP\AQ_PoS_SD01_T25_ProposedSampling_QAPP.mxd

ANCHOR QEA

Figure 3
Proposed Sampling Locations
Quality Assurance Project Plan
Port of Seattle Terminal 25 South Design Characterization



Existing Relative to Subgrade Elevations		Existing Relative to Subgrade Elevations	
Range (ft)	Color	Range (ft)	Color
-17.0 to -16.0		-4.0 to -3.0	
-16.0 to -15.0		-3.0 to -2.0	
-15.0 to -14.0		-2.0 to -1.0	
-14.0 to -13.0		-1.0 to 0.0	
-13.0 to -12.0		0.0 to +1.0	
-12.0 to -11.0		+1.0 to +2.0	
-11.0 to -10.0		+2.0 to +3.0	
-10.0 to -9.0		+3.0 to +4.0	
-9.0 to -8.0		+4.0 to +5.0	
-8.0 to -7.0		+5.0 to +6.0	
-7.0 to -6.0		+6.0 to +7.0	
-6.0 to -5.0		+7.0 to +8.0	
-5.0 to -4.0		+8.0 to +9.0	

SOURCE: Drawing prepared from survey by The Watershed Company. Bathymetry from the Port of Seattle, dated January-March 2018.
HORIZONTAL DATUM: Washington State Plane North, NAD83, U.S. Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND
- Existing OHWM
- Proposed Contour (2-foot Interval)
- Proposed Slope Centerline
- Proposed Mean High High Water
- Proposed Cribwall
- Proposed Berm with Large Woody Debris
- Proposed Intertidal Shelf
- Proposed Bio-cement Mattress
- Proposed Eel Grass Bench
- Proposed Kelp Bench
- Potential Excavation Area
- A Cross Section Location and Designation

UPLAND BORING LOCATIONS
- Chemistry
- Chemistry and Geotechnical

SEDIMENT CORING LOCATIONS
- Sample Location

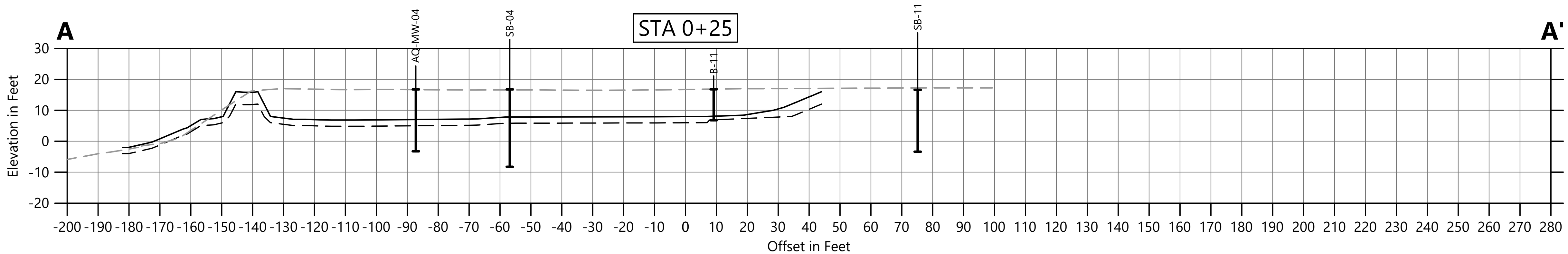
HISTORICAL BORINGS
- Geotech Boring (Shannon and Wilson, 2008)
- Soil Boring (Blymyer, 1989)
- Soil Boring and Monitoring Well (Landau, 1990)
- Soil Boring and Monitoring Well (Sweet-Edwards/Emcon, 1990)
- Soil Boring and Monitoring Well (Anchor QEA, 2012)
- Surface Sediment Composite (Anchor QEA, 2012)

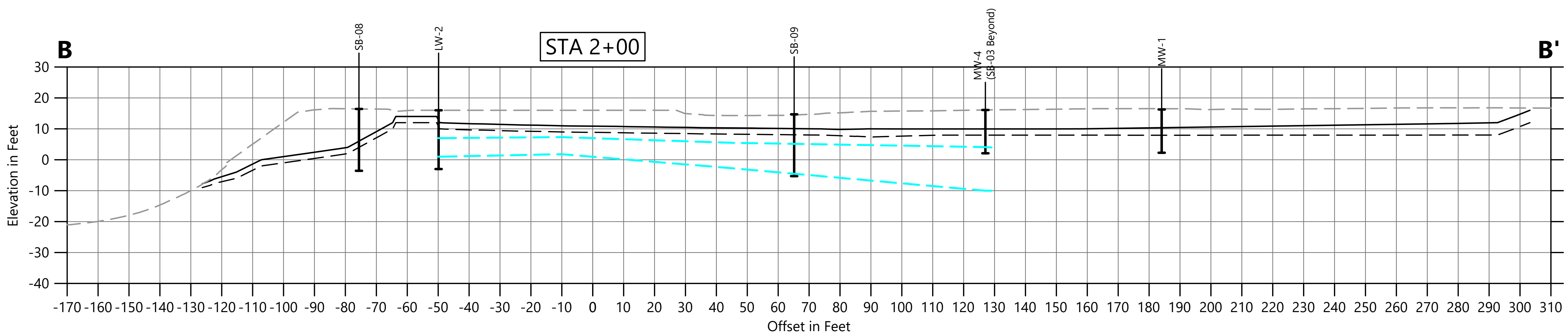
0 100
Feet

Publish Date: 2018/11/15 2:08 PM | User: chewett
Filepath: K:\Projects\0003-Port of Seattle\POS SD-01 - T-25 Wetland\0003-WK-006 (TWC Design and XS).dwg F4_Land

ANCHOR QEA

Figure 4
Project Elevation Changes
Quality Assurance Project Plan
Port of Seattle Terminal 25 South Design Characterization





SOURCE: Drawing prepared from survey by The Watershed Company. Bathymetry from the Port of Seattle, dated January-March 2018.
HORIZONTAL DATUM: Washington State Plane North, NAD83, U.S. Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

Existing Grade

Proposed Grade

Proposed Subgrade

Approximate Top and Bottom of Wood Debris

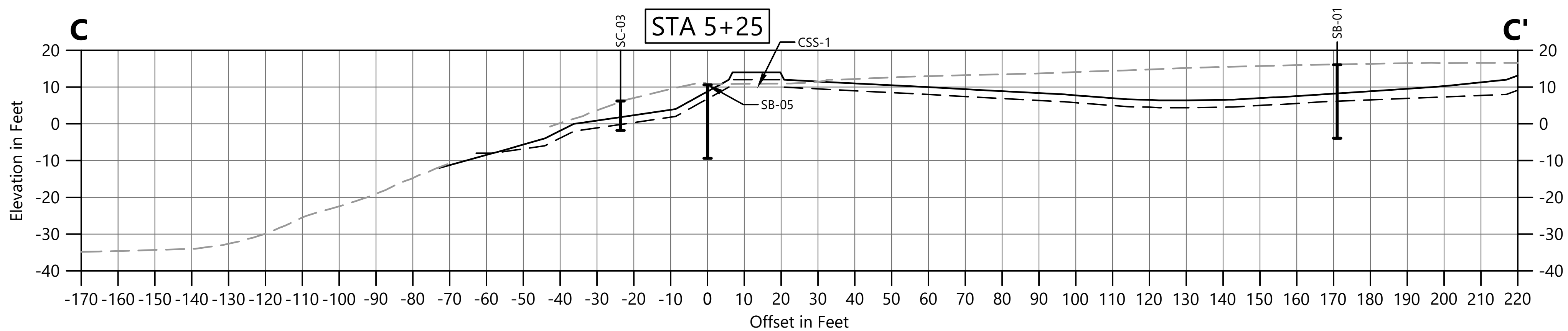
0 40
Feet

Publish Date: 2018/05/30 1:34 PM | User: tgriga
Filepath: K:\Projects\0003-Port of Seattle\POS SD-01 - T-25 Wetland\0003-WK-006 (TWC Design and XS).dwg Figure 5a

ANCHOR QEA

Figure 5a
Cross Sections

Quality Assurance Project Plan
Port of Seattle Terminal 25 South Design Characterization



SOURCE: Drawing prepared from survey by The Watershed Company. Bathymetry from the Port of Seattle, dated January-March 2018.
HORIZONTAL DATUM: Washington State Plane North, NAD83, U.S. Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:
Existing Grade
Proposed Grade
Proposed Subgrade

0 40
Feet

Publish Date: 2018/05/30 1:34 PM | User: tgriga
Filepath: K:\Projects\0003-Port of Seattle\POS SD-01 - T-25 Wetland\0003-WK-006 (TWC Design and XS).dwg Figure 5b

ANCHOR QEA

Figure 5b
Cross Sections

Quality Assurance Project Plan
Port of Seattle Terminal 25 South Design Characterization

Appendix A
Health and Safety Plan

Appendix B
Field Collection Forms

PROJECT:	Log of Boring No.	
BORING LOCATION:	ELEVATION AND DATUM:	
DRILLING CONTRACTOR:	DATE STARTED:	DATE COMPLETED:
DRILLING METHOD:	TOTAL DEPTH:	MEASURING POINT:
DRILLING EQUIPMENT:	DEPTH TO FIRST WATER ATD:	DEPTH TO FREE WATER ATC:
SAMPLING METHOD:	LOGGED BY:	
BOREHOLE DIAMETER:	HAMMER TYPE/SYSTEM:	

DEPTH (feet)	SAMPLES		PID Reading (ppm)	DESCRIPTION	FIELD-ESTIMATED %						SAMPLE ID OTHER REMARKS
					Gravel		Sand			Fines	
	Recovery	Blows/ 6 inches			Coarse	Fine	Coarse	Medium	Fine		

Project No.	ANCHOR QEA	Page 1 of ___

PROJECT:					Log of Boring No.						
DEPTH (feet)	SAMPLES			DESCRIPTION	FIELD-ESTIMATED %						SAMPLE ID OTHER REMARKS
					Gravel		Sand				
	Recovery	Blows/ 6 inches	PID Reading (ppm)		Coarse	Fine	Coarse	Medium	Fine	Fines	

Project No.	ANCHOR QEA	Page ___ of ___

PROTOCOL MODIFICATION FORM

Project Name and Number: ____________________

Material to be Sampled: ____________________

Measurement Parameter: ____________________

Standard Procedure for Field Collection & Laboratory Analysis (cite reference):

Reason for Change in Field Procedure or Analysis Variation: ____________________

Variation from Field or Analytical Procedure: ____________________

Special Equipment, Materials or Personnel Required: ____________________

Initiator's Name: ____________________ Date: __________

Project Manager: ____________________ Date: __________

QA Manager: ____________________ Date: __________

SEDIMENT CORE COLLECTION FORM

Core ID: ____________ **Station ID:** ____________

Project Name: ____________ **Uncorrected depth:** ____________

Project Number: ____________ **NOS water level (tide):** ____________

Date: ____________ **Time:** ____________ **NOS-to-ACOE level correction:** ____________

Weather: ____________ **ACOE water level (tide):** ____________

Crew: ____________ **Water depth (ACOE MLLW):** ____________

Core penetration: ____________ **Core recovery:** ____________ **Percent recovery:** ____________

Depth		Sample data		USCS soil group	Notes:
Ft below mud surface	Sample interval	Sample number	Percent recovery		
					Lithology/observations:
1					
2					
3					
4					
5					
6					
7					
8					

SEDIMENT CORE COLLECTION FORM

Core ID: ______________ **Station ID:** ______________

Project Name: ______________ **Uncorrected depth:** ______________

Project Number: ______________ **NOS water level (tide):** ______________

Date: __________ **Time:** __________ **NOS-to-ACOE level correction:** ______________

Weather: ______________ **ACOE water level (tide):** ______________

Crew: ______________ **Water depth (ACOE MLLW):** ______________

Core penetration: __________ **Core recovery:** __________ **Percent recovery:** __________

Depth		Sample data		USCS soil group	Notes:
Ft below mud surface	Sample interval	Sample number	Percent recovery		
					Lithology/observations:
9					
10					
11					
12					
13					
14					
15					
16					

Appendix C
Historical Data

Blymyer Engineers, Inc.

Exploratory Bore Log

Client: Matson Terminals
Site: Terminal 25 POS

Date: 12-1-88
Job#: 88289
Rig: Hollow Stem Auger

Driller: Soil Sampling Service
Logged by: Sue Black

Diameter: 4"
Boring No.: B-10

Description and Remarks	Color	Blow Counts	Consist.	Soil Type	Depth	Sample	Notes
Asphalt					1		
Fill - Medium Sand with Trace Fines, Little Gravel, Moist	Dark Gray	3-5-7	Loose	SM	5		Very Slight Solvent Odor (5 ppm)
Silty Clayey Sand, Wood Fragments, Gravels, Wet	Dark Gray/ Black	3-2-5	Loose	SC	10		Slight Hydro-carbon & Organic Odor (10 ppm)
							Bottom of Bore 10'
					15		
					20		
					25		
					30		

Blymyer Engineers, Inc.

Exploratory Bore Log

Client: Matson Terminals
Site: Terminal 25 POS

Date: 12-1-88
Job#: 88289
Rig: Hollow Stem Auger

Driller: Soil Sampling Service
Logged by: Sue Black

Diameter: 4"
Boring No.: B-11

Description and Remarks	Color	Blow Counts	Consist.	Soil Type	Depth	Sample	Notes
Asphalt							
Fill- Medium to Coarse Sand, Trace Fines, Little Gravel, Moist	Light Gray	6-6-10	Medium Dense	SP	5		No Odor (0 ppm)
Silty Clay, Trace Sand, Organic, Wood Fragments, Wet	Black	1-1-1	Very Loose	OL	10		Organic Odor (0 ppm)
					15		Bottom of Bore 10'
					20		
					25		
					30		

Blymyer Engineers, Inc.

Exploratory Bore Log

Client: Matson Terminals
Site: Terminal 25 POS

Date: 12-1-88
Job#: 88289
Rig: Hollow Stem Auger

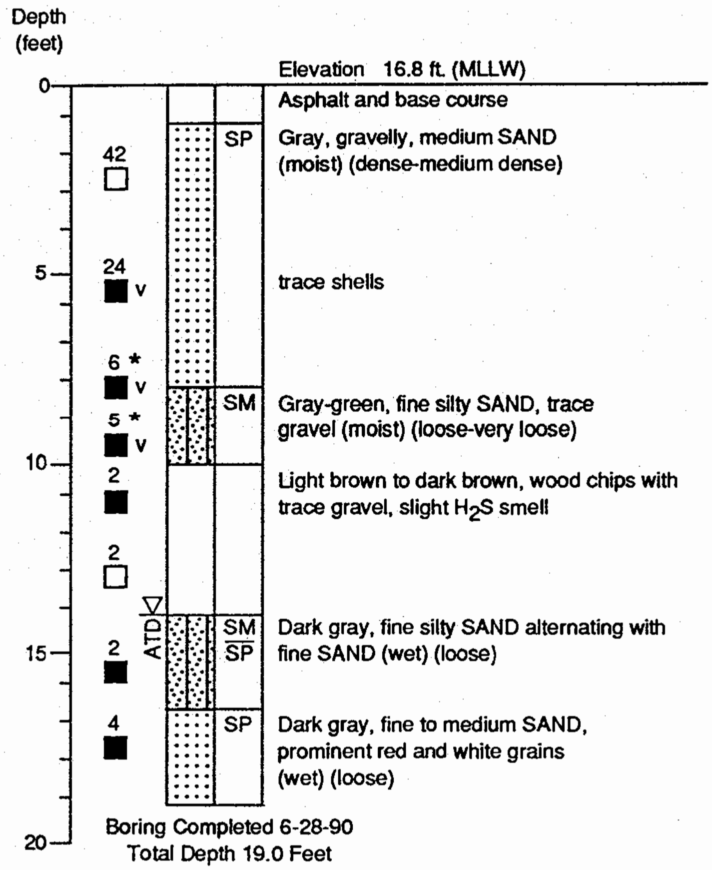
Driller: Soil Sampling Service
Logged by: Sue Black

Diameter: 4"
Boring No.: B- 12

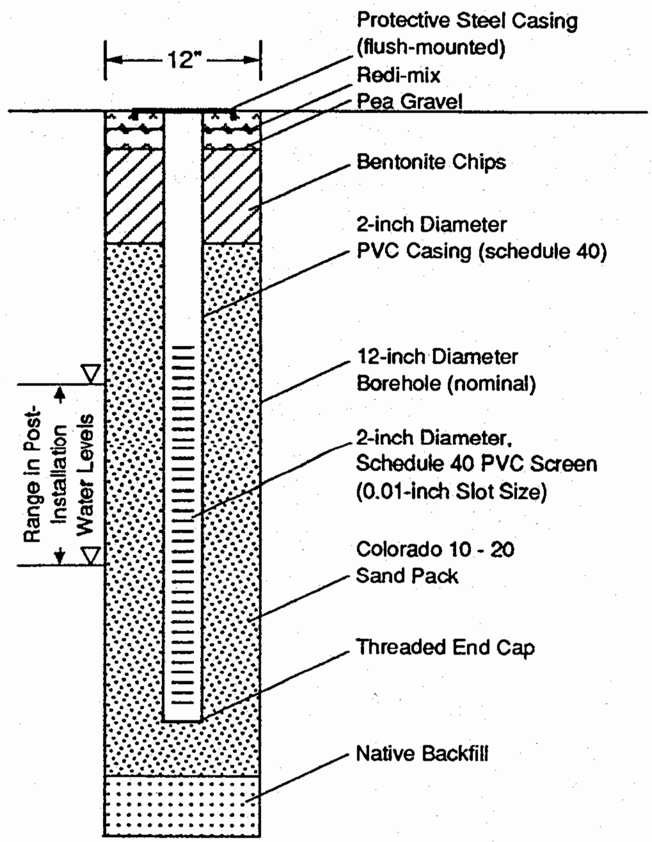
Description and Remarks	Color	Blow Counts	Consist.	Soil Type	Depth	Sample	Notes
Asphalt							
Fill- Medium to Coarse Sand, Trace Fines, Little Gravel, Moist	Light Gray	8-4-6	Medium Dense	SP	5		No Odor (0 ppm)
Silty Clay, Trace Sand, Organic, Wood Fragments, Wet	Black	1-2-1	Loose	OL	10		Organic Odor (0 ppm)
					15		Bottom of Bore 10'
					20		
					25		
					30		

Well LW-1

Soil Profile



Well Detail



KEY

* ← Indicates sample collected for chemical analysis

102 ← Blows required to drive 2.42-inch I.D. split barrel sampler 1 foot with a hammer weight of 140 pounds and a stroke of 30 inches

■ ← Indicates depth at which relatively undisturbed sample was extracted

Relative Field UV Fluorescence Observations:

- V — Very weak
- W — Weak
- M — Moderate
- (no symbol) — No fluorescence

☒ ← Indicates depth of disturbed sample

□ ← Indicates sample attempt with no recovery

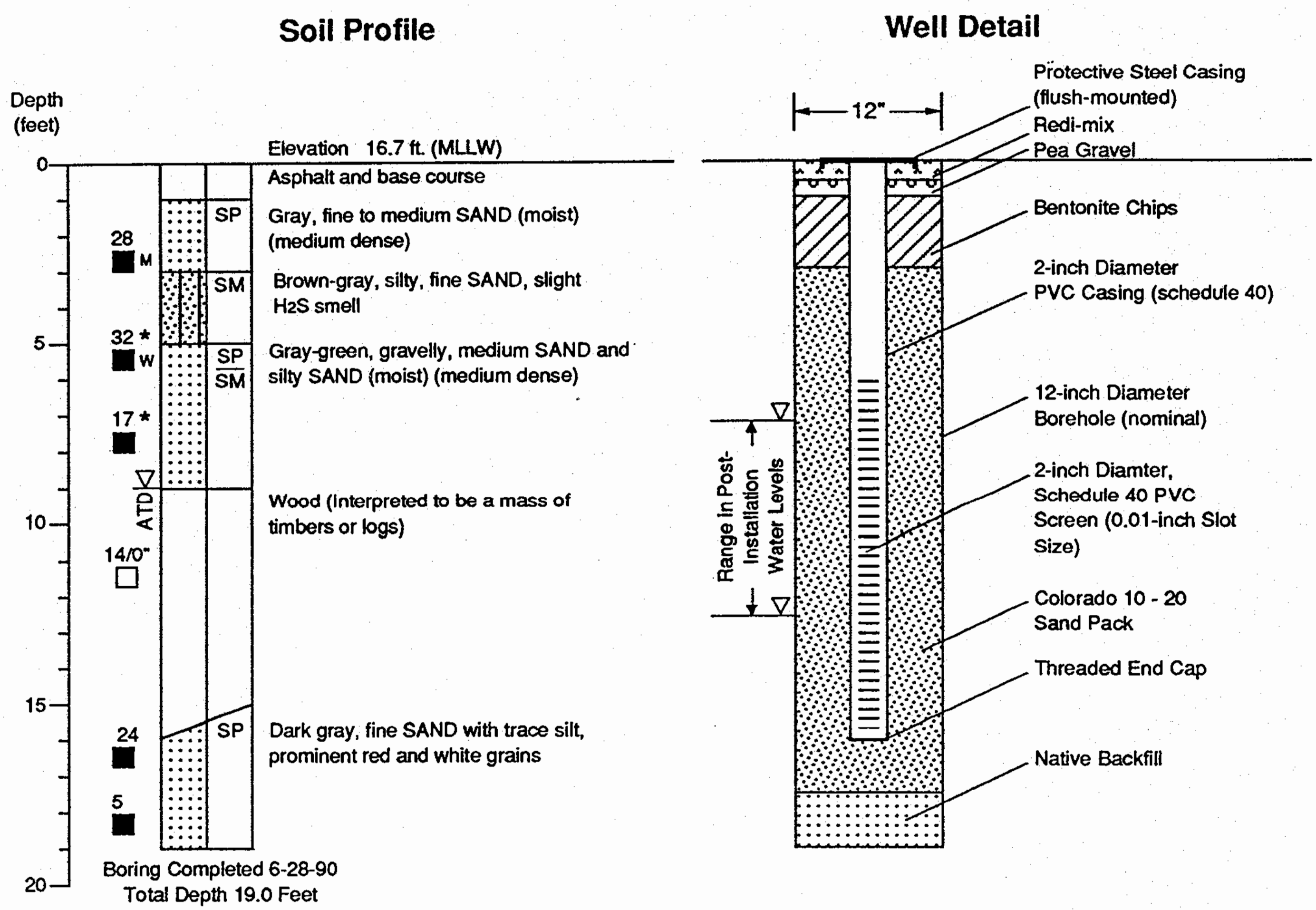
▽ ATD ← Water level encountered at time of drilling (Note: See text for subsequent ground water level measurements)

50-03.10 Port of Seattle/Terminal 25/Soil and Ground Water Investigation/Final Report 10/5/90

LANDAU ASSOCIATES, INC.	Soil Profile and Well Detail for Well LW-1

Figure A-2

Well LW-2



KEY

- * ← Indicates sample collected for chemical analysis
- 102 ← Blows required to drive 2.42-inch I.D. split barrel sampler 1 foot with a hammer weight of 140 pounds and a stroke of 30 inches
- ■ ← Indicates depth at which relatively undisturbed sample was extracted

Relative Field UV Fluorescence Observations:

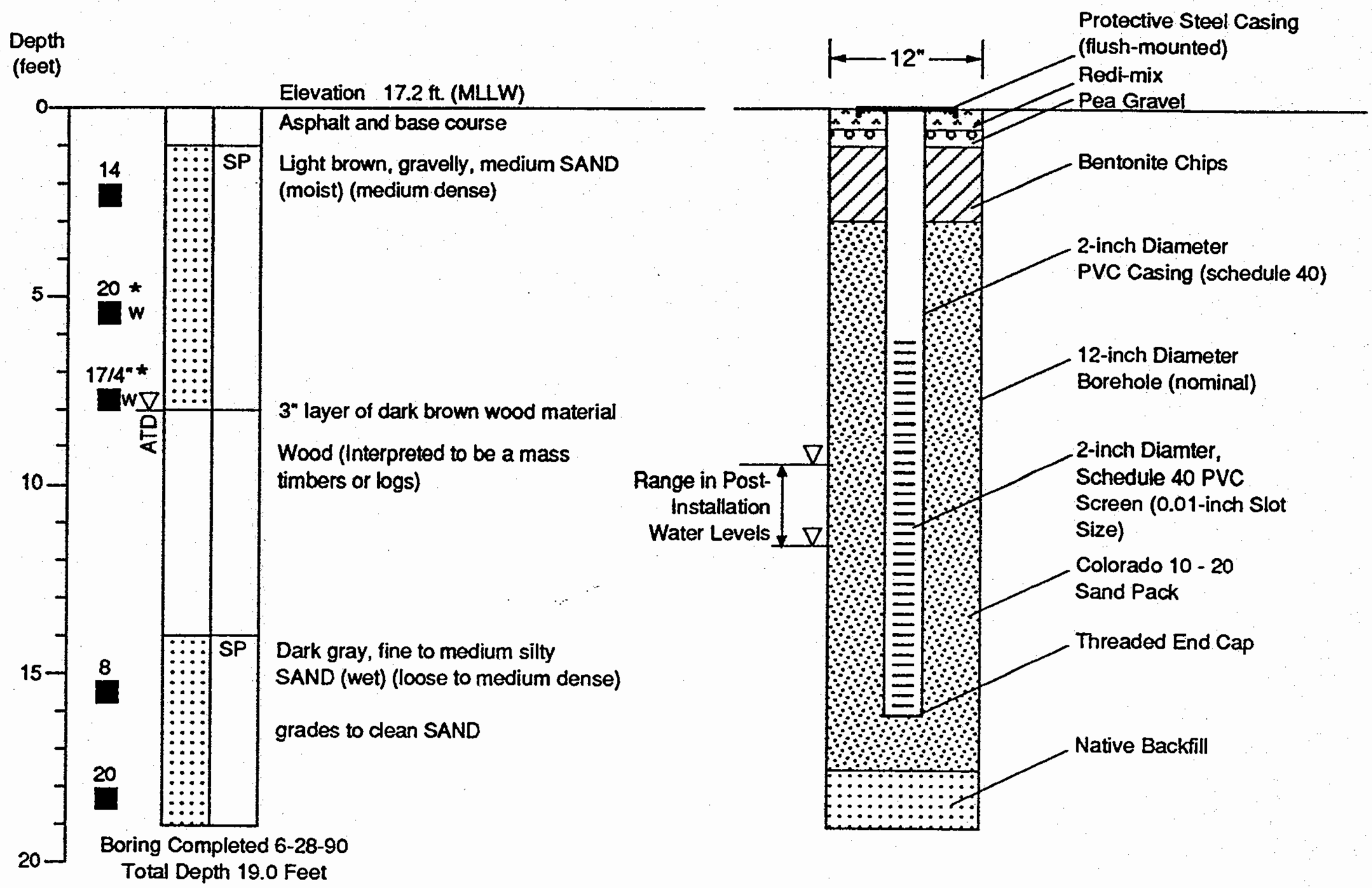
- V — Very weak
- W — Weak
- M — Moderate
- (no symbol) — No fluorescence

- ☒ ← Indicates depth of disturbed sample
- ☐ ← Indicates sample attempt with no recovery
- ▽ ATD ← Water level encountered at time of drilling (Note: See text for subsequent ground water level measurements)

Well LW-3

Soil Profile

Well Detail



KEY

* ← Indicates sample collected for chemical analysis

102 ← Blows required to drive 2.42-inch I.D. split barrel sampler 1 foot with a hammer weight of 140 pounds and a stroke of 30 inches

■ ← Indicates depth at which relatively undisturbed sample was extracted

Relative Field UV Fluorescence Observations:

- V — Very weak
- W — Weak
- M — Moderate
- (no symbol) — No fluorescence

☒ ← Indicates depth of disturbed sample

☐ ← Indicates sample attempt with no recovery

▽ ATD ← Water level encountered at time of drilling (Note: See text for subsequent ground water level measurements)

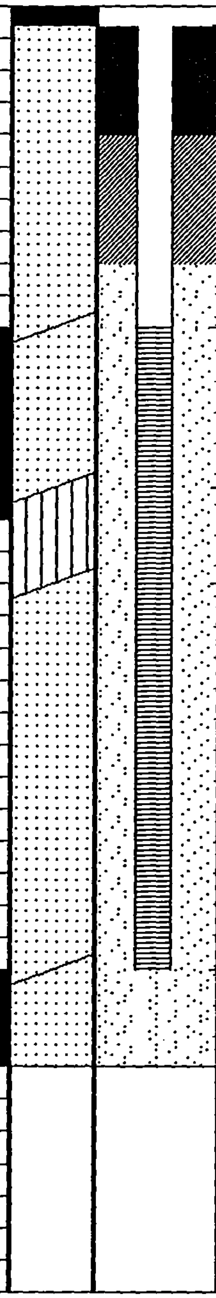
LANDAU ASSOCIATES, INC.	Soil Profile and Well Detail for Well LW-3

LOG OF EXPLORATORY BORING

PROJECT NAME	Port of Seattle	BORING NO.	MW- 1
LOCATION	Terminal 25	PAGE	1 OF 1
DRILLED BY	GEO BORING	REFERENCE ELEV.	4.69' MSL
DRILL METHOD	4" ID HSA	TOTAL DEPTH	16.50'
LOGGED BY	John Guenther	DATE COMPLETED	10/12/89

SAMPLE TYPE AND NUMBER	TIP READING	BLOWS PER FOOT	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC DESCRIPTION
						0 - 4 inches: ASPHALT Paving.
						4 inches - 5 feet: SAND, dark grey/brown. Trace fine gravel. Damp, wet wood odor.
SS 1	0	5 18 32		5		5 - 7.5 feet: SAND, grey brown; trace fines. Trace fine gravel. Damp, dense. Wet wood odor.
SS 2	< / = 21	20 27 39				
						7.5 - 9 feet: SANDY SILT, dark grey. 25-40 percent fine sand, saturated. Dense. No odor.
			∇	10		9 - 15 feet: SILTY SAND, dark grey, fine sand, 10-20 percent silt, saturated. Dense. Wet wood odor.
SS 3	0	0 1 3		15		15 - 16.5 feet: SAWDUST - WOOD CHIPS, saturated, loose. Sulfer Odor.
						Bottom of boring at 16.5 feet.
				20		

LITHO-LOGIC COLUMN / WELL DETAILS:



REMARKS

See attached legend for well construction details.

LOG OF EXPLORATORY BORING

PROJECT NAME	Port of Seattle	BORING NO.	MW- 2
LOCATION	Terminal 25	PAGE	1 OF 1
DRILLED BY	GEO BORING	REFERENCE ELEV.	4.66' MSL
DRILL METHOD	4" ID HSA	TOTAL DEPTH	16.50'
LOGGED BY	John Guenther	DATE COMPLETED	10/12/89

SAMPLE TYPE AND NUMBER	TIP READING	BLOWS PER FOOT	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
								0 - 4 inches: ASPHALT Paving.
								4 inches - 5 feet: SAND, dark grey. Medium sand. Trace fines. Trace fine gravel. Damp, no odor.
SS 1	< / = 12	20 32 32		5				5 - 6.5 feet: SAND, dark grey, medium sand, trace fine gravel. Damp, dense. Slight wet wood odor.
SS 2	0	9 10 13						6.5 - 15 feet: SAND, grey, medium-coarse sand. Trace fine gravel. Saturated. Medium dense. No odor.
			∇	10				
SS 3	0	1 0 0		15				15 - 16.5 feet: SAND; dark grey; fine to medium sand; trace silt. Loose, saturated. Wood chips. No Odor.
								Bottom of boring at 16.5 feet.
				20				

REMARKS

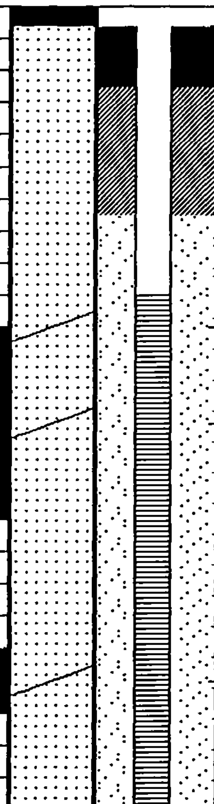
See attached legend for well construction details.

LOG OF EXPLORATORY BORING

PROJECT NAME	Port of Seattle	BORING NO.	MW- 3
LOCATION	Terminal 25	PAGE	1 OF 1
DRILLED BY	GEO BORING	REFERENCE ELEV.	3.84' MSL
DRILL METHOD	4" ID HSA	TOTAL DEPTH	12.50'
LOGGED BY	John Guenther	DATE COMPLETED	10/12/89

SAMPLE TYPE AND NUMBER	TIP READING	BLOWS PER FOOT	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC DESCRIPTION
				0		0 - 4 inches: ASPHALT Paving.
						4 inches - 5 feet: SAND, dark grey/brown; medium sand, trace fines. Damp. Wet wood odor.
SS 1	0	8 26 17		5		5 - 6.5 feet: SAND, dark grey; fine to medium. Dense, moist, clean. No odor.
SS 2	0	5 8 13	∇			6.5 - 10 feet: SAND, dark grey; fine to medium sand; trace to little silt. Saturated, medium dense. No odor.
SS 3	0	7 50		10		10.5 - 12.5 feet: WOOD CHUNKS AND SAWDUST; saturated, sulfer odor.
						Bottom of boring at 12.5 feet. Refusal on wood.
				15		
				20		

LITHO-LOGIC COLUMN / WELL DETAILS



REMARKS

See attached legend for well construction details.

LOG OF EXPLORATORY BORING

PROJECT NAME	Port of Seattle	BORING NO.	MW- 4
LOCATION	Terminal 25	PAGE	1 OF 1
DRILLED BY	GEO BORING	REFERENCE ELEV.	4.09' MSL
DRILL METHOD	4" ID HSA	TOTAL DEPTH	14.00'
LOGGED BY	John Guenther	DATE COMPLETED	10/12/89

SAMPLE TYPE AND NUMBER	TIP READING	BLOWS PER FOOT	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
								0 - 4 inches: ASPHALT Paving.
								4 inches - 5 feet: SAND, dark grey, medium sand. Trace fine gravel. Damp, dense, wet wood odor.
SS 1	0	15 21 15		5				5 - 6.5 feet: SAND, grey; medium coarse sand, trace silt. Damp, dense. No odor.
SS 2	0	7 13 21	∇					6.5 - 12 feet: SAND, grey, medium coarse sand. Saturated, dense. No odor.
				10				
SS 3	0	17 21 21						12 - 14 feet: SILTY SAND, dark brown/grey, fine sand, 10-20 percent silt. Saturated. Wood debris. 14 foot: Auger refusal in wood debris at 14 foot.
				15				Bottom of boring at 14 feet.
				20				

REMARKS

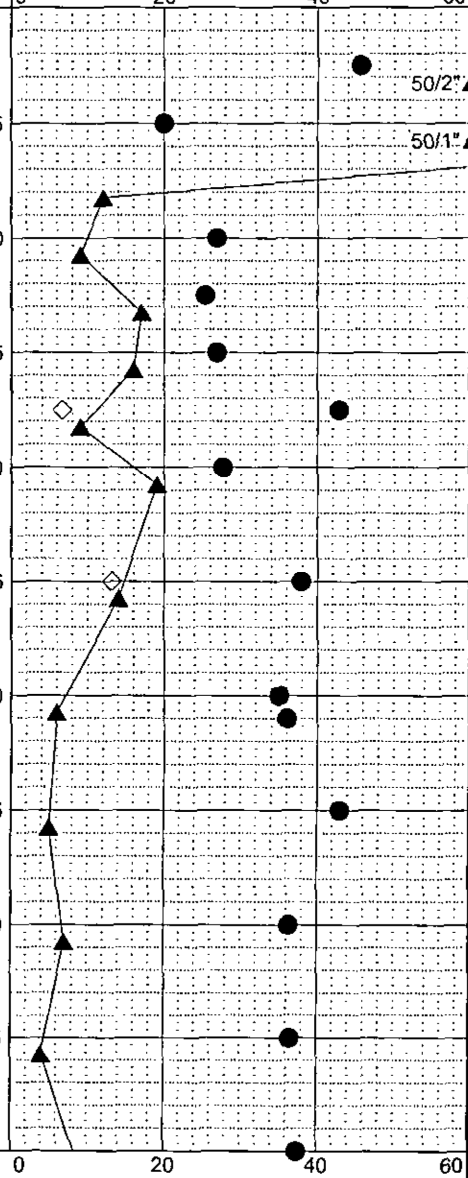
See attached legend for well construction details.

Total Depth:	81.5 ft.	Northing:		Drilling Method:	Mud Rotary	Hole Diam.:	
Top Elevation:	~	Easting:		Drilling Company:	Boart Longyear	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Mobile B-59	Hammer Type:	Automatic
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Samples
Dark brown, slightly gravelly to gravelly SAND, trace of silt; moist; SP.	2.0	
Very dense, gray, slightly sandy GRAVEL; moist; GP.	7.0	1, 2
Medium dense, slightly sandy WOOD; moist; PT.	10.5	3
Loose, dark gray, slightly sandy to sandy SILT, trace of clay; moist; abundant wood; ML.	12.0	4
Medium dense to loose, black with red flecks, slightly silty, fine to medium SAND, trace of silt; wet; scattered to abundant wood layers, scattered to abundant silt layers/seams; SP-SM.	31.0	5, 6, 7, 8, 9
Medium stiff, gray-brown, slightly clayey SILT; moist; abundant organics; ML.		10, 11, 12, 13

Ground Water: During Drilling

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- Ground Water Level ATD

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. USCS designation is based on visual-manual classification and selected lab testing.

Port of Seattle
Terminal 25 South Expansion - Phase 2
Seattle, Washington

LOG OF BORING B-1

October 2008 21-21044-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 1 of 2

REV 1

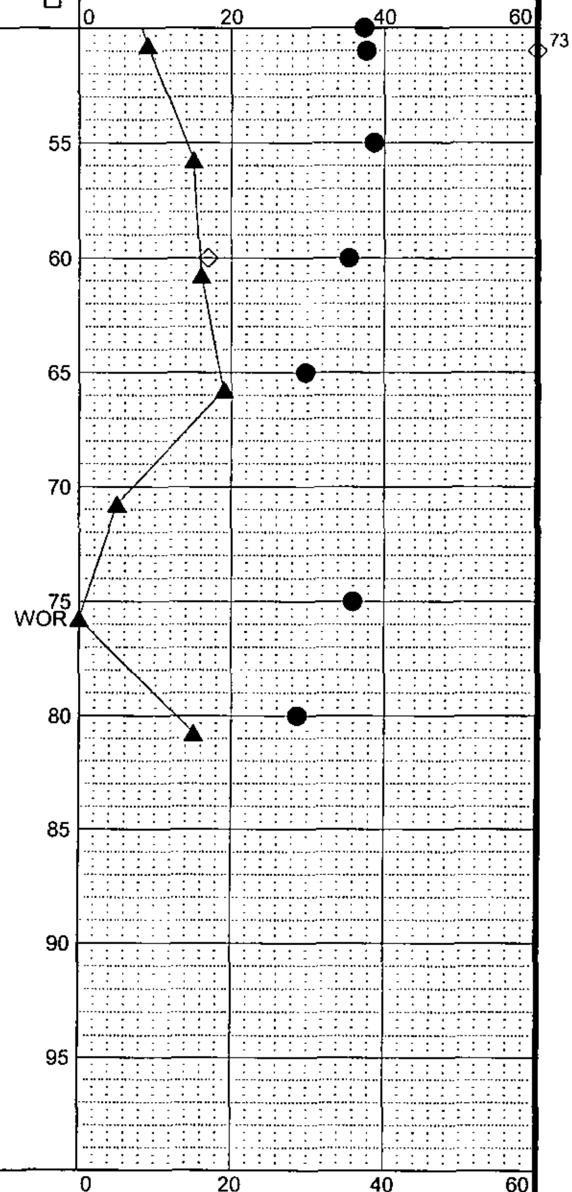
Total Depth:	*81.5 ft.*	Northing:		Drilling Method:	*Mud Rotary*	Hole Diam.:	
Top Elevation:	~	Easting:		Drilling Company:	*Boart Longyear*	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	*Mobile B-59*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION	Depth, ft.	Samples
Loose, black with red flecks, slightly silty, fine to medium SAND; wet; abundant organics; SP.	50.0 / 51.0	14
Medium stiff, gray-brown, clayey SILT; moist to very moist; ML-MH.	54.0	15
Medium dense, black with red flecks, slightly silty to silty, fine to medium SAND and gray-brown SILT; moist to wet; scattered to abundant organics; SP-SM/ML.		16
Medium dense, black with red flecks, slightly silty to silty SAND; moist to wet; scattered organics; SP-SM.	64.0	17
Very soft, gray-brown, silty CLAY/clayey SILT; moist; scattered organics; CL-ML.	68.0	18, 19
Medium dense, black with red flecks, slightly silty, fine to medium SAND and gray-brown SILT; moist to wet; SP/ML.	78.0	20
BOTTOM OF BORING COMPLETED 10/6/2008	81.5	

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Symbol | Ground Water

PENETRATION RESISTANCE (blows/foot)
▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



◇ % Fines (<0.075mm)
● % Water Content

LEGEND

* Sample Not Recovered
Ⅰ Standard Penetration Test
▽ Ground Water Level ATD

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. USCS designation is based on visual-manual classification and selected lab testing.

Port of Seattle
Terminal 25 South Expansion - Phase 2
Seattle, Washington

LOG OF BORING B-1

October 2008 | 21-21044-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-2
Sheet 2 of 2

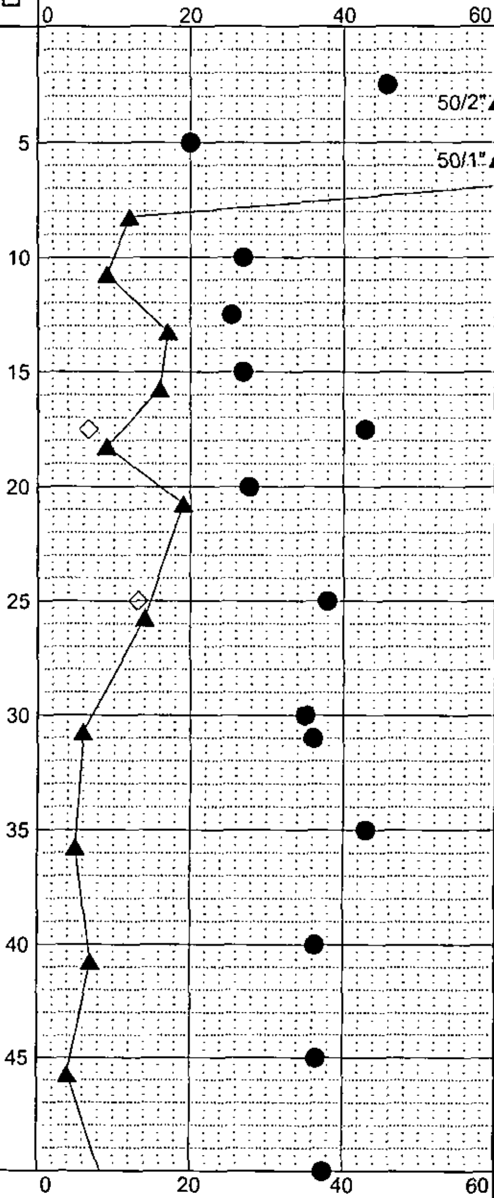
REV 1

Total Depth:	81.5 ft.	Northing:		Drilling Method:	Mud Rotary	Hole Diam.:	
Top Elevation:	~	Easting:		Drilling Company:	Boart Longyear	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Mobile B-59	Hammer Type:	Automatic
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Samples	Ground Water
Dark brown, slightly gravelly to gravelly SAND, trace of silt; moist; SP.	2.0		
Very dense, gray, slightly sandy GRAVEL; moist; GP.	7.0	1, 2	
Medium dense, slightly sandy WOOD; moist; PT.	10.5	3	
Loose, dark gray, slightly sandy to sandy SILT, trace of clay; moist; abundant wood; ML.	12.0	4	
Medium dense to loose, black with red flecks, slightly silty, fine to medium SAND, trace of silt; wet; scattered to abundant wood layers, scattered to abundant silt layers/seams; SP-SM.	31.0	5, 6, 7, 8, 9	During Drilling ∇
Medium stiff, gray-brown, slightly clayey SILT; moist; abundant organics; ML.		10, 11, 12, 13	

CONTINUED NEXT SHEET

PENETRATION RESISTANCE (blows/foot)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches



◇ % Fines (<0.075mm)
● % Water Content

LEGEND

* Sample Not Recovered
⌶ Standard Penetration Test
∇ Ground Water Level ATD

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. USCS designation is based on visual-manual classification and selected lab testing.

Port of Seattle
Terminal 25 South Expansion - Phase 2
Seattle, Washington

LOG OF BORING B-1

October 2008 | 21-21044-001

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FIG. A-2
Sheet 1 of 2

REV 1

Total Depth:	81.5 ft.	Northing:		Drilling Method:	Mud Rotary
Top Elevation:	~	Easting:		Drilling Company:	Boart Longyear
Vert. Datum:		Station:		Drill Rig Equipment:	Mobile B-59
Horiz. Datum:		Offset:		Other Comments:	

Hole Diam.:
Rod Diam.:
Hammer Type: Automatic

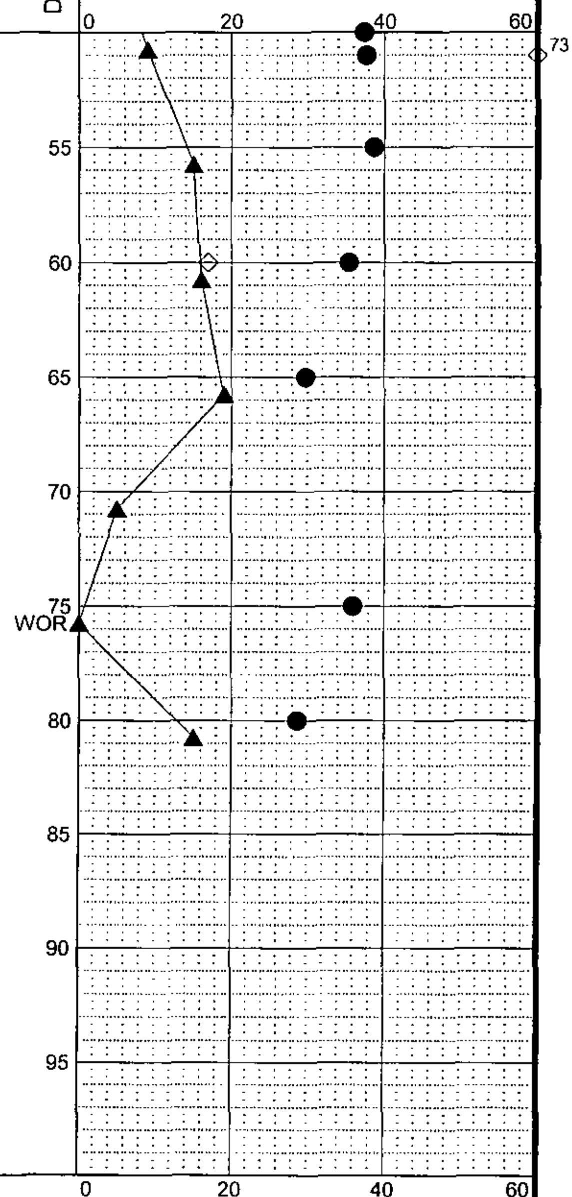
SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soil Description	Depth, ft.	Samples
Loose, black with red flecks, slightly silty, fine to medium SAND; wet; abundant organics; SP.	50.0 – 51.0 – 54.0	14
Medium stiff, gray-brown, clayey SILT; moist to very moist; ML-MH.	54.0	15
Medium dense, black with red flecks, slightly silty to silty, fine to medium SAND and gray-brown SILT; moist to wet; scattered to abundant organics; SP-SM/ML.	64.0	16
Medium dense, black with red flecks, slightly silty to silty SAND; moist to wet; scattered organics; SP-SM.	68.0	17
Very soft, gray-brown, silty CLAY/clayey SILT; moist; scattered organics; CL-ML.	78.0	18, 19
Medium dense, black with red flecks, slightly silty, fine to medium SAND and gray-brown SILT; moist to wet; SP/ML.	81.5	20

BOTTOM OF BORING
COMPLETED 10/6/2008

PENETRATION RESISTANCE (blows/foot)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches



◇ % Fines (<0.075mm)
● % Water Content

LEGEND

* Sample Not Recovered
⌶ Standard Penetration Test
$\underline{\nabla}$ Ground Water Level ATD

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
3. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
4. Groundwater level, if indicated above, is for the date specified and may vary.
5. USCS designation is based on visual-manual classification and selected lab testing.

Port of Seattle
Terminal 25 South Expansion - Phase 2
Seattle, Washington

LOG OF BORING B-1

October 2008 21-21044-001

SHANNON & WILSON, INC.
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FIG. A-2
Sheet 2 of 2

REV 1

MASTER_LOG_E 21-21044.GPJ SHAN_WIL.GDT 10/22/08 Log: ELM Rev: MDH Typ: CLP

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
110003-01	AQ-MW-1	1 of 1

Project Name:	Terminal 25-S	Ground Surface Elev	
Location:	Seattle, Washington	Top of Casing Elev.	12.54
Driller/Method:	Cascade-Lynn / Geoprobe truck rig	Depth to Water (ft BGS)	5
Sampling Method:	Continuous	Start/Finish Date	10/21/2012

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Blows/ 6"	Material Type	Description	Depth (ft)
	5"-diameter monument mounted flush in concrete			0			**FILL** Slightly moist, gray, black, and brown, silty, sandy GRAVEL (GM); crushed rock, asphalt debris	
				0				
	3/4"-diameter Sch 40 PVC riser			0				
				0			Moist to wet, brown to dark brown, silty SAND (SM); well-graded fine-to-coarse sand	
5				0				5
				0				
	Hydrated bentonite chips			0			Wood debris	
				0				
				0				
10				0				10
				0				
	10-20 sand			0				
				0				
				0				
15	3/4"-diameter 0.020"-slot Sch 40 PVC screen prepacked with 10-20 sand			0				15
				0			**HOLOCENE ALLUVIUM** Wet, black, slightly silty SAND (SP-SM); poorly graded fine-to-medium sand, rare red clasts	
				0				
	Slip cap			0				
	Slough			0				
20							Bottom of boring at 20 ft,	20
							Water level datum is MLLW Epoch 1983-2001	

Sampler Type:

No Recovery

Continuous Core

PID - Photoionization Detector

▼ Static Water Level

▽ Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 2

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
110003-01	AQ-MW-2	1 of 1

Project Name:	Terminal 25-S	Ground Surface Elev	
Location:	Seattle, Washington	Top of Casing Elev.	16.3
Driller/Method:	Cascade-Lynn / Geoprobe truck rig	Depth to Water (ft BGS)	7.2
Sampling Method:	Continuous	Start/Finish Date	10/21/2012

Column headings: Depth / Elevation (feet) | Borehole Completion | Sample Type/ID | Tests | PID (ppm) | Blows/ 6" | Material Type | Description | Depth (ft)

Borehole Completion:
- 5"-diameter monument mounted flush in concrete
- 3/4"-diameter Sch 40 PVC riser
- Hydrated bentonite chips
- 10-20 sand
- 3/4"-diameter 0.020"-slot Sch 40 PVC screen prepacked with 10-20 sand
- Slip cap

PID (ppm) (at approximately 1-ft intervals, 1 to 19 ft): 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

Depth markers: 5, 10, 15, 20

Description:

Asphalt

FILL

Slightly moist, gray, black, and brown, silty, sandy GRAVEL (GM); crushed rock, base course

Moist to wet, brown to dark brown, slightly silty, gravelly SAND (SM); well-graded fine-to-coarse sand

Wet, brown and dark gray, silty SAND (SM); abundant wood debris

HOLOCENE ALLUVIUM

Wet, black, slightly silty SAND (SP-SM); poorly graded fine-to-medium sand, rare red clasts

Bottom of boring at 20 ft,

Water level datum is MLLW Epoch 1983-2001

Sampler Type:
- No Recovery
- Continuous Core

PID - Photoionization Detector

- Static Water Level
- Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 3

Aspect CONSULTING

Monitoring Well Construction Log

Project Number	Well Number	Sheet
110003-01	AQ-MW-3	1 of 1

Project Name: Terminal 25-S
Location: Seattle, Washington
Driller/Method: Cascade-Lynn / Geoprobe truck rig
Sampling Method: Continuous

Ground Surface Elev:
Top of Casing Elev.: 16.66
Depth to Water (ft BGS): 7.5
Start/Finish Date: 10/21/2012

Borehole Completion:
- 5"-diameter monument mounted flush in concrete
- 3/4"-diameter Sch 40 PVC riser
- Hydrated bentonite chips
- 10-20 sand
- 3/4"-diameter 0.020"-slot Sch 40 PVC screen prepacked with 10-20 sand
- Slip cap

Depth (ft)	PID (ppm)	Description
0–0.5		Asphalt
0.5–1.5	0	**FILL** Slightly moist, gray, black, and brown, silty, sandy GRAVEL (GM); crushed rock (base course)
1.5–11	0	Moist to wet, brown to dark brown, slightly silty, gravelly SAND (SM); poorly graded fine-to-medium sand
	0	Seashell fragments
	0, 0, 0, 0, 0	Becomes wet
	0, 0	Sulfide-like odor
11–14	0, 0, 0	Wood debris
14–17	0, 0, 0	Wet, brown, silty SAND (SM)
17–20	0, 0, 0	**HOLOCENE ALLUVIUM** Wet, black, slightly silty SAND (SP-SM); poorly graded fine-to-medium sand, rare red clasts
20		Bottom of boring at 20 ft,
		Water level datum is MLLW Epoch 1983-2001

Sampler Type:
- No Recovery
- Continuous Core

PID - Photoionization Detector
- Static Water Level
- Water Level (ATD)

Logged by: Mv
Approved by: SJG
Figure No. A- 4

Monitoring Well Construction Log

Aspect CONSULTING

Project Number	Well Number	Sheet
110003-01	AQ-MW-4	1 of 1

Project Name:	Terminal 25-S	Ground Surface Elev	
Location:	Seattle, Washington	Top of Casing Elev.	17.03
Driller/Method:	Cascade-Lynn / Geoprobe truck rig	Depth to Water (ft BGS)	7
Sampling Method:	Continuous	Start/Finish Date	10/21/2012

Depth / Elevation (feet)	Borehole Completion	Sample Type/ID	Tests	PID (ppm)	Blows/ 6"	Material Type	Description	Depth (ft)
	5"-diameter monument mounted flush in concrete			0			Asphalt	
				0			**FILL** Slightly moist, gray, black, and brown, silty, sandy GRAVEL (GM); crushed rock (base course)	
	3/4"-diameter Sch 40 PVC riser			0			Moist to wet, brown to dark brown, slightly silty, gravelly SAND (SM); poorly graded fine-to-medium sand	
				0				
5	Hydrated bentonite chips			0				5
				0			Brick debris	
				0			Becomes wet, silty.	
				0			Abundant woody debris	
				0				
10				0			Sulfide-like odor	10
				0			Wood debris	
				0				
				0				
	10-20 sand			0			Wet, brown, silty SAND (SM)	
15				0				15
	3/4"-diameter 0.020"-slot Sch 40 PVC screen prepacked with 10-20 sand			0				
				0			**HOLOCENE ALLUVIUM** Wet, black, slightly silty SAND (SP-SM); poorly graded fine-to-medium sand, rare red clasts	
				0				
	Slip cap			0				
20							Bottom of boring at 20 ft,	20
							Water level datum is MLLW Epoch 1983-2001	

Sampler Type:

No Recovery

Continuous Core

PID - Photoionization Detector

Static Water Level

Water Level (ATD)

Logged by: Mv

Approved by: SJG

Figure No. A- 5

Sediment Core Log

CORE: EW10-SC06

Project: **East Waterway SRI/FS**	Location: **East Waterway**	Tube Length (ft): **14.55**
Project #: **060003-01.17**	Water Elevation (ft)/Tide: **8.3**	Penetration Depth (ft): **14.35**
Client: **Port of Seattle**	Water Depth (ft): **36.3**	Recovery Length (ft): **11.55**
Collection Date: **2/22/2010**	Surveyed Mudline Elevation (ft): **-29.4**	Process Date: **2/23/2010**
Contractor: **AMEC**	N/LAT: **47 34.3570 N** E/LONG: **122 20.6736 W**	Process Method: **Cut tube**
Vessel: **R/V Investigator**	Horiz. Datum: **WGS 84** Vert. Datum: **MLLW**	Sample Quality: **Good**
Operator: **Gary Maxwell**	Method/Tube ID: **MudMole/3.88" sq**	Logged By: **LM/AO**

Recoverd Detph (ft)	Recovered Interval & Sample	Geotech Sample	Chemical Analysis	PID Measurement	**Sediment Description** Samples and Descriptions are in Recovered Depths In-Situ Depths Shown on Right Classification Scheme: USCS	*In-situ* Depth (ft) & Graphic Log
0–2	EW10-SC06-0-2		SVOC, PCB, Metals, TOC/TS, GS, Butyltins	2	(ML) Moist, soft, black, clayey SILT, trace f-sand, trace subrounded f-gravel (1/2"-diameter). Silt is smooth and homogenous. Trace wood fragments and twigs, trace shell fragments. Moderate H2S odor. @ 1.8': Piece of glass, wood fragment (2.5"-long, cedar)	Recent
2–4	EW10-SC06-2-4		SVOC, PCB, Metals, TOC/TS, GS, Butyltins	69.9	@ 2': Thin bed of f-sandy, SILT (ML)	
					(SP) Moist, medium dense, black, f-SAND. Sand grains are multicolored and are red, beige, black, white, and gray.	Transition
				72	(ML) Moist, medium stiff, olive gray, SILT. Substantial decomposed wood fragments (3"-long, brown). Moderate H2S odor.	
4–6	EW10-SC06-4-6		Mercury	170	@ 4.8': Wood piece (3"x 3"-wide)	
				78	@ 5.1': Grades to damp, slightly clayey, SILT. Silt has a blocky texture. Occasional wood fragments, trace wood fibers (hair-like)	
				31		
6–7.4	EW10-SC06-6-7.4		Mercury	7.8		
				0	@ 6.9': Grades to slightly f-sandy, SILT. Trace wood fragments	
7.4–8	EW10-SC06-7				(SP) Damp, dense, dark gray, f-SAND and occasional pockets and stratified beds of SILT (ML) Moderate wood fragments (1"-long).	

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Footnote(1): Attempt 1 of 1

Footnote (2):

Calculated Recovery
Recovery Length/Penetration Depth:
11.55/14.35 ft 80.5%

Sediment Core Log

CORE: EW10-SC06

Project: **East Waterway SRI/FS**	Location: **East Waterway**	Tube Length (ft): **14.55**
Project #: **060003-01.17**	Water Elevation (ft)/Tide: **8.3**	Penetration Depth (ft): **14.35**
Client: **Port of Seattle**	Water Depth (ft): **36.3**	Recovery Length (ft): **11.55**
Collection Date: **2/22/2010**	Surveyed Mudline Elevation (ft): **-29.4**	Process Date: **2/23/2010**
Contractor: **AMEC**	N/LAT: **47 34.3570 N** E/LONG: **122 20.6736 W**	Process Method: **Cut tube**
Vessel: **R/V Investigator**	Horiz. Datum: **WGS 84** Vert. Datum: **MLLW**	Sample Quality: **Good**
Operator: **Gary Maxwell**	Method/Tube ID: **MudMole/3.88" sq**	Logged By: **LM/AO**

Recoverd Detph (ft)	Recovered Interval & Sample	Geotech Sample	Chemical Analysis	PID Measurement	**Sediment Description** Samples and Descriptions are in Recovered Depths In-Situ Depths Shown on Right Classification Scheme: USCS	*In-situ* Depth (ft) & Graphic Log
8–10	EW10-SC06-7.4-10		Mercury	0	(SP) Damp, dense, dark gray, f-SAND and occasional pockets and stratified beds of SILT (ML) Moderate wood fragments (1"-long). @ 8.9': Wood chunk (3.5"-long, yellow)	Transition
10–11.45	EW10-SC06-10-11.4		Archive	0	(SM) Damp, dense, dark gray, slightly silty, f-SAND and occasional laminated and stratified beds of SILT (ML). Moderate wood fragments. @ 11.4': Decomposed wood chunk (3"-long, cedar)	Native
					End of core at 11.45'.	

Depth scale: 8, 9, 10, 11, 12, 13, 14, 15, 16

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Footnote(1): Attempt 1 of 1

Footnote (2):

Calculated Recovery
Recovery Length/Penetration Depth:
11.55/14.35 ft 80.5%

Sediment Core Log

CORE: EW10-SC08

Project: **East Waterway SRI/FS**	Location: **East Waterway**	Tube Length (ft): **14.55**
Project #: **060003-01.17**	Water Elevation (ft)/Tide: **10.1**	Penetration Depth (ft): **14.32**
Client: **Port of Seattle**	Water Depth (ft): **45.4**	Recovery Length (ft): **12.32**
Collection Date: **2/22/2010**	Surveyed Mudline Elevation (ft): **-36.1**	Process Date: **2/23/2010**
Contractor: **AMEC**	N/LAT: **47 34.4087 N** E/LONG: **122 20.6430 W**	Process Method: **Cut tube**
Vessel: **R/V Investigator**	Horiz. Datum: **WGS 84** Vert. Datum: **MLLW**	Sample Quality: **Good**
Operator: **Gary Maxwell**	Method/Tube ID: **MudMole/3.88" sq**	Logged By: **LM/AO**

Recoverd Detph (ft)	Recovered Interval & Sample	Geotech Sample	Chemical Analysis	PID Measurement	**Sediment Description** Samples and Descriptions are in Recovered Depths In-Situ Depths Shown on Right Classification Scheme: USCS	*In-situ* Depth (ft) & Graphic Log
0	EW10-SC08-0-2		SVOC, PCB, Metals, TOC/TS, GS	0.1	(ML) Moist, medium stiff, black with olive gray mottling, slightly sandy, very clayey SILT. Silt is smooth and homogenous. Trace biota (worm) and rootlets. Moderate H2S odor.	0 Recent
2	EW10-SC08-2-4		SVOC, PCB, Metals, TOC/TS, GS	15.2	@ 2': Grades to soft @ 2.5': Grades to blocky. Trace shell fragments. Trace metallic sheen and moderate HC-like odor.	2
4	EW10-SC08-4-6		Archive	1.7 0	(ML) Moist, soft, olive gray, slightly clayey, SILT. Silt is smooth and homogeneous. Trace fresh wood fragments (1"-long, yellow/brown). Trace HC-like odor. @ 6': Bone piece (2.5"-long)	4
6	EW10-SC08-6-8		SVOC, PCB, Mercury, Cadmium	0		6
8						8

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Footnote(1): Attempt 1 of 1

Footnote (2):

Calculated Recovery
Recovery Length/Penetration Depth:
12.32/14.32 ft = 86.0%

Sediment Core Log

CORE: EW10-SC08

Project: **East Waterway SRI/FS**	Location: **East Waterway**	Tube Length (ft): **14.55**
Project #: **060003-01.17**	Water Elevation (ft)/Tide: **10.1**	Penetration Depth (ft): **14.32**
Client: **Port of Seattle**	Water Depth (ft): **45.4**	Recovery Length (ft): **12.32**
Collection Date: **2/22/2010**	Surveyed Mudline Elevation (ft): **-36.1**	Process Date: **2/23/2010**
Contractor: **AMEC**	N/LAT: **47 34.4087 N** E/LONG: **122 20.6430 W**	Process Method: **Cut tube**
Vessel: **R/V Investigator**	Horiz. Datum: **WGS 84** Vert. Datum: **MLLW**	Sample Quality: **Good**
Operator: **Gary Maxwell**	Method/Tube ID: **MudMole/3.88" sq**	Logged By: **LM/AO**

Recoverd Detph (ft)	Recovered Interval & Sample	Geotech Sample	Chemical Analysis	PID Measurement	**Sediment Description** Samples and Descriptions are in Recovered Depths In-Situ Depths Shown on Right Classification Scheme: USCS	*In-situ* Depth (ft) & Graphic Log
8–9.4	EW10-SC08-8-9.4		Mercury	0	(SM) Damp, medium dense, dark gray, slightly silty, f-SAND and trace pockets and laminated beds of SILT (ML). Sand grains are multicolored and are red, beige, black, white, and gray. Occasional decomposed wood fragments (1"-long, cedar) and layers of wood fragments (1/16"-long).	Recent
9.4–11	EW10-SC08-9.4-11		Mercury	0		Native
11–12.5	EW10-SC08-11-12.5		Archive	0	(SP) Moist, medium dense, dark gray, f-SAND.	
					(ML) Moist, soft, light gray, SILT.	
					(SP) Moist, medium dense, dark gray, f-SAND. @ 12.4': Winnowing to end of core	
					End of core at 12.65'.	

Depth scale (ft): 8, 9, 10, 11, 12, 13, 14, 15, 16

Revised 6-16-2010

ANCHOR QEA
1423 Third Avenue
Seattle, WA 98101
206-287-9130

Footnote(1): Attempt 1 of 1

Footnote (2):

Calculated Recovery
Recovery Length/Penetration Depth:
12.32/14.32 ft = 86.0%

Sediment Core Log

CORE: EW10-SC09

Project: **East Waterway SRI/FS**	Location: **East Waterway**	Tube Length (ft): **15**
Project #: **060003-01.17**	Water Elevation (ft)/Tide: **8.2**	Penetration Depth (ft): **14**
Client: **Port of Seattle**	Water Depth (ft): **46.3**	Recovery Length (ft): **13.1**
Collection Date: **3/8/2010**	Surveyed Mudline Elevation (ft): **-40.4**	Process Date: **3/9/2010**
Contractor: **MSS**	N/LAT: **47 34.4207 N** E/LONG: **122 20.5875 W**	Process Method: **Cut tube**
Vessel: **R/V Nancy Anne**	Horiz. Datum: **WGS 84** Vert. Datum: **MLLW**	Sample Quality: **Good**
Operator: **Bill Jaworski**	Method/Tube ID: **Vibracore/3.75" round**	Logged By: **LM/ML**

Recoverd Detph (ft)	Recovered Interval & Sample	Geotech Sample	Chemical Analysis	PID Measurement	**Sediment Description** Samples and Descriptions are in Recovered Depths In-Situ Depths Shown on Right Classification Scheme: USCS	*In-situ* Depth (ft) & Graphic Log
0	EW10-SC09-0-2		SVOC, PCB, Metals, TOC/TS, GS	0 2.5 9.3 7.8	(ML) Wet to moist, soft, olive gray grading to black, m-sandy, clayey SILT. Trace organics, wood fragments (1"-long), and shell fragments. Strong H2S odor. @ 0.9': Wood fragment (3"-long) @ 1-1.2': Agglomerate of asphalt, barnacles and shells fused together (3.75"-long)	0 1
2	EW10-SC09-2-4		SVOC, PCB, Metals, TOC/TS, GS	16.8 3.7 0.3	@ 2.3': Agglomerate of asphalt, barnacles and shells fused together (3"-long). Strong H2S odor @ 3.8': 1" Layer of wood fragments and fibers (2"-long)	2 3
4	EW10-SC09-4-6		Archive	0	@ 4.1': Grades to fissured texture. Piece of subangular c-gravel (1"-diameter) @ 5.5': 1" layer of wood fragments (2"-long) and c-gravel (1.5"-diameter)	4 5
6	EW10-SC09-6-7.2		SVOC, PCB, Mercury	0	@ 6.2': Layer of shell fragments (1/2"-diameter) @ 6.8': Piece of glass (1"-long) and piece of flexible plastic (4"-long). Strong H2S odor	6 7
7.2	EW10-SC09-7.2-9				(SP) Damp, medium dense, dark gray, f-SAND. Sand grains are multicolored and are red, beige, black, white, and gray. (SP) Damp, medium dense, dark gray, f-SAND and moderate laminated and stratified beds of damp, medium stiff,	Recent Native 8

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Seattle, WA 98101
206-287-9130

Footnote(1): Attempt 1 of 1

Footnote (2):

Calculated Recovery
Recovery Length/Penetration Depth:
13.1/14 ft = 93.6%

Revised 6-16-2010

Sediment Core Log

CORE: EW10-SC09

Project: **East Waterway SRI/FS**	Location: **East Waterway**	Tube Length (ft): **15**
Project #: **060003-01.17**	Water Elevation (ft)/Tide: **8.2**	Penetration Depth (ft): **14**
Client: **Port of Seattle**	Water Depth (ft): **46.3**	Recovery Length (ft): **13.1**
Collection Date: **3/8/2010**	Surveyed Mudline Elevation (ft): **-40.4**	Process Date: **3/9/2010**
Contractor: **MSS**	N/LAT: **47 34.4207 N** E/LONG: **122 20.5875 W**	Process Method: **Cut tube**
Vessel: **R/V Nancy Anne**	Horiz. Datum: **WGS 84** Vert. Datum: **MLLW**	Sample Quality: **Good**
Operator: **Bill Jaworski**	Method/Tube ID: **Vibracore/3.75" round**	Logged By: **LM/ML**

Recoverd Detph (ft)	Recovered Interval & Sample	Geotech Sample	Chemical Analysis	PID Measurement	**Sediment Description** Samples and Descriptions are in Recovered Depths In-Situ Depths Shown on Right Classification Scheme: USCS	*In-situ* Depth (ft) & Graphic Log
8	**EW10-SC09-7.2-9.2**		Mercury		(SP) Damp, medium dense, dark gray, f-SAND and moderate laminated and stratified beds of damp, medium stiff, olive gray, SILT (ML). Sand grains are multicolored and are red, beige, black, white, and gray.	8 Native
9				0		9
10	**EW10-SC09-9.2-11.2**		Mercury			10
11				0		11
12	**EW10-SC09-11.2-12.5**		Archive		@ 11.8': Grades to trace fresh wood fragments (1/2"-long, orange)	12
					End of core at 12.5'.	
13						13
14						14
15						15
16						16

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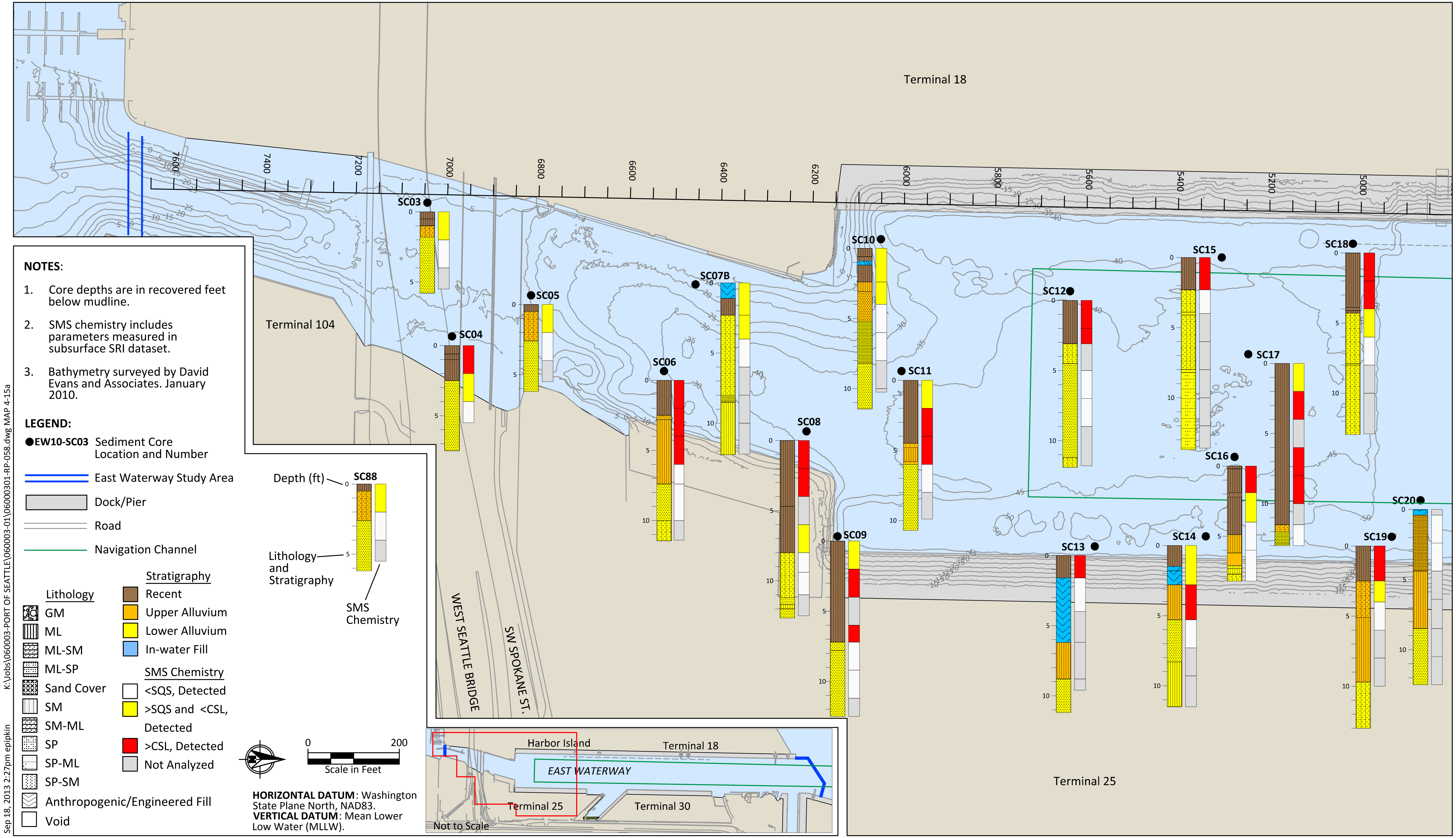
Seattle, WA 98101
206-287-9130

Footnote(1): Attempt 1 of 1

Footnote (2):

Calculated Recovery
Recovery Length/Penetration Depth:
13.1/14 ft = 93.6%



Map 4-15a

Subsurface Sediment Core Profiles with SMS Chemistry

Supplemental Remedial Investigation

East Waterway Operable Unit

East Waterway Surface Sediment Chemistry

Chemical	Unit	EW09-SS-015-010 6/23/2009	EW09-SS-016-010 6/22/2009	EW09-SS-018-010 6/22/2009	EW09-SS-020-010 3/4/2009	EW10-04-COMP 8/19/2009	EW10-05-COMP 8/19/2009	EW10-06-COMP 8/19/2009
Metals								
Antimony	mg/kg dw	20 UJ	7 UJ	20 UJ	10 UJ	--	--	--
Arsenic	mg/kg dw	8.2	4.8	5.8	12.9	--	--	--
Cadmium	mg/kg dw	0.8 U	0.3 U	0.7 U	0.8	--	--	--
Chromium	mg/kg dw	23	33.6	25	34	--	--	--
Cobalt	mg/kg dw	5	6.6 J	6 J	8.1	--	--	--
Copper	mg/kg dw	43.9	38.6 J	35.2	83.9	--	--	--
Lead	mg/kg dw	32	35 J	88 J	54	--	--	--
Mercury	mg/kg dw	0.11 J	0.08	0.11	0.75 J	--	--	--
Molybdenum	mg/kg dw	3	2.7 J	4 J	1 UJ	--	--	--
Nickel	mg/kg dw	15	26	20	21	--	--	--
Selenium	mg/kg dw	0.8 U	0.7 U	0.7 U	1 U	--	--	--
Silver	mg/kg dw	1 U	0.4 U	6	0.6 U	--	--	--
Thallium	mg/kg dw	0.3 U	0.3 U	0.3 U	0.4 U	--	--	--
Vanadium	mg/kg dw	41	46.6	38	67.7	--	--	--
Zinc	mg/kg dw	89 J	94 J	235 J	155	--	--	--
PAHs								
1-Methylnaphthalene	µg/kg dw	90	20 U	2,700	20 U	86 J	290 J	4,400 J
2-Chloronaphthalene	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
2-Methylnaphthalene	µg/kg dw	120	20 U	2,800	20 U	91 J	430 J	5,200 J
Acenaphthene	µg/kg dw	230	32	3,000	60	170 J	890 J	5,600 J
Acenaphthylene	µg/kg dw	70	89	350	73	130 J	130 J	80 UJ
Anthracene	µg/kg dw	290	290	6,500	390	390 J	2,300 J	11,000 J
Benzo(a)anthracene	µg/kg dw	430	410	9,000	740	980 J	2,300 J	16,000 J
Benzo(a)pyrene	µg/kg dw	480	440	7,800	760	1,400 J	3,200 J	12,000 J
Benzo(b)fluoranthene	µg/kg dw	870	420	5,400	890	--	--	--
Benzo(g,h,i)perylene	µg/kg dw	140	100	1,800	330 J	640 J	940 J	2,200 J
Benzo(k)fluoranthene	µg/kg dw	520	420	5,400	740	--	--	--
Total benzofluoranthenes	µg/kg dw	1,390	840	10,800	1,630	2,400 J	6,300 J	20,000 J
Chrysene	µg/kg dw	1,200	590	11,000	1,400	1,600 J	4,400 J	17,000 J
Dibenzo(a,h)anthracene	µg/kg dw	58 J	27	690	140 J	190 J	460 J	1,300 J
Dibenzofuran	µg/kg dw	330	26	1,100	46	93 J	640 J	2,100 J
Fluoranthene	µg/kg dw	2,900	830	20,000	2,100	3,500 J	11,000 J	44,000 J
Fluorene	µg/kg dw	290	65	3,800	110	210 J	1,100 J	8,300 J
Indeno(1,2,3-cd)pyrene	µg/kg dw	150	110	1,800	330 J	540 J	1,000 J	2,500 J
Naphthalene	µg/kg dw	210	20 U	3,000	22	240 J	980 J	5,600 J
Phenanthrene	µg/kg dw	3,400	310	24,000	740	2,600 J	7,900 J	62,000 J
Pyrene	µg/kg dw	1,600	820	20,000	1,500	3,800 J	9,100 J	52,000 J
Total HPAHs	µg/kg dw	8,300 J	4,170	83,000	8,900 J	15,100 J	39,000 J	167,000 J

East Waterway Surface Sediment Chemistry

Chemical	Unit	EW09-SS-015-010 6/23/2009	EW09-SS-016-010 6/22/2009	EW09-SS-018-010 6/22/2009	EW09-SS-020-010 3/4/2009	EW10-04-COMP 8/19/2009	EW10-05-COMP 8/19/2009	EW10-06-COMP 8/19/2009
Total LPAHs	µg/kg dw	4,500	790	41,000	1,400	3,700 J	13,300 J	93,000 J
cPAHs - mammal - half DL	µg/kg dw	710 J	590	10,000	1,100 J	1,900 J	4,400 J	17,000 J
Total PAHs	µg/kg dw	12,800 J	4,950	124,000	10,300 J	18,800 J	52,000 J	260,000 J
Phthalates								
Bis(2-ethylhexyl)phthalate	µg/kg dw	220	200	300	240	--	--	--
Butyl benzyl phthalate	µg/kg dw	47	15 U	15 U	27	--	--	--
Diethyl phthalate	µg/kg dw	15 U	20 U	46 U	15 U	--	--	--
Dimethyl phthalate	µg/kg dw	15 U	15 U	15 U	15 U	--	--	--
Di-n-butyl phthalate	µg/kg dw	20 U	55	59 U	20 U	--	--	--
Di-n-octyl phthalate	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
Other SVOCs								
1,2,4-Trichlorobenzene	µg/kg dw	6.1 U	6.0 U	5.9 U	6.1 U	--	--	--
1,2-Dichlorobenzene	µg/kg dw	6.1 U	6.0 U	5.9 U	6.1 U	--	--	--
1,3-Dichlorobenzene	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
1,4-Dichlorobenzene	µg/kg dw	6.7	6.0 U	5.9 U	15	--	--	--
2,4,5-Trichlorophenol	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
2,4,6-Trichlorophenol	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
2,4-Dichlorophenol	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
2,4-Dimethylphenol	µg/kg dw	6.1 U	6.0 U	15	6.1 U	--	--	--
2,4-Dinitrophenol	µg/kg dw	200 U	200 U	590 U	200 U	--	--	--
2,4-Dinitrotoluene	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
2,6-Dinitrotoluene	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
2-Chlorophenol	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
2-Methylphenol	µg/kg dw	6.1 U	6.0 U	13	6.1 U	--	--	--
2-Nitroaniline	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
2-Nitrophenol	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
3,3'-Dichlorobenzidine	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
3-Nitroaniline	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
4,6-Dinitro-o-cresol	µg/kg dw	200 U	200 U	590 U	200 U	--	--	--
4-Bromophenyl phenyl ether	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
4-Chloro-3-methylphenol	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
4-Chloroaniline	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
4-Chlorophenyl phenyl ether	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
4-Methylphenol	µg/kg dw	20 U	20 U	76	30	--	--	--
4-Nitroaniline	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
4-Nitrophenol	µg/kg dw	100 U	98 U	290 U	98 UJ	--	--	--
Aniline	µg/kg dw	R	20 UJ	59 UJ	20 U	--	--	--
Benzoic acid	µg/kg dw	200 UJ	200 U	590 U	200 U	--	--	--
Benzyl alcohol	µg/kg dw	20 U	20 U	30 U	20 UJ	--	--	--

East Waterway Surface Sediment Chemistry

Chemical	Unit	EW09-SS-015-010 6/23/2009	EW09-SS-016-010 6/22/2009	EW09-SS-018-010 6/22/2009	EW09-SS-020-010 3/4/2009	EW10-04-COMP 8/19/2009	EW10-05-COMP 8/19/2009	EW10-06-COMP 8/19/2009
bis(2-chloroethoxy)methane	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
bis(2-chloroethyl)ether	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
bis(2-chloroisopropyl)ether	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
Carbazole	µg/kg dw	260	66	2,200	110	--	--	--
Hexachlorobenzene	µg/kg dw	5.0 U	6.0 U	5.9 U	6.1 U	--	--	--
Hexachlorobutadiene	µg/kg dw	5.0 U	6.0 U	5.9 U	6.1 U	--	--	--
Hexachlorocyclopentadiene	µg/kg dw	100 U	98 U	290 U	98 U	--	--	--
Hexachloroethane	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
Isophorone	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
n-Nitroso-di-n-propylamine	µg/kg dw	30 U	30 U	30 U	31 U	--	--	--
n-Nitrosodimethylamine	µg/kg dw	30 U	30 U	30 U	31 U	--	--	--
n-Nitrosodiphenylamine	µg/kg dw	6.1 U	6.0 U	47 U	6.1 U	--	--	--
Nitrobenzene	µg/kg dw	20 U	20 U	59 U	20 U	--	--	--
Pentachlorophenol	µg/kg dw	30 U	30 U	30 U	31 U	--	--	--
Phenol	µg/kg dw	20 U	20 U	140	20	--	--	--
PCBs								
Aroclor-1016	µg/kg dw	13 U	23 U	10 U	19 U	--	--	--
Aroclor-1221	µg/kg dw	13 U	23 U	10 U	19 U	--	--	--
Aroclor-1232	µg/kg dw	13 U	23 U	10 U	19 U	--	--	--
Aroclor-1242	µg/kg dw	13 U	51	10 U	19 U	--	--	--
Aroclor-1248	µg/kg dw	48	23 U	25	19 U	--	--	--
Aroclor-1254	µg/kg dw	120	370	92	19 U	--	--	--
Aroclor-1260	µg/kg dw	170	420	140	29	--	--	--
Aroclor-1262	µg/kg dw	13 U	23 U	10 U	19 U	--	--	--
Aroclor-1268	µg/kg dw	13 U	23 U	10 U	19 U	--	--	--
Total PCBs	µg/kg dw	340	840	260	29	--	--	--
Pesticides								
2,4'-DDD	µg/kg dw	10 U	--	--	--	--	--	--
2,4'-DDE	µg/kg dw	10 U	--	--	--	--	--	--
2,4'-DDT	µg/kg dw	10 U	--	--	--	--	--	--
4,4'-DDD	µg/kg dw	10 U	--	--	--	--	--	--
4,4'-DDE	µg/kg dw	10 U	--	--	--	--	--	--
4,4'-DDT	µg/kg dw	10 U	--	--	--	--	--	--
Total DDTs	µg/kg dw	10 U	--	--	--	--	--	--
Aldrin	µg/kg dw	270 U	--	--	--	--	--	--
Dieldrin	µg/kg dw	10 U	--	--	--	--	--	--
Total aldrin/dieldrin	µg/kg dw	270 U	--	--	--	--	--	--
alpha-BHC	µg/kg dw	5.0 U	--	--	--	--	--	--
beta-BHC	µg/kg dw	5.0 U	--	--	--	--	--	--

East Waterway Surface Sediment Chemistry

Chemical	Unit	EW09-SS-015-010 6/23/2009	EW09-SS-016-010 6/22/2009	EW09-SS-018-010 6/22/2009	EW09-SS-020-010 3/4/2009	EW10-04-COMP 8/19/2009	EW10-05-COMP 8/19/2009	EW10-06-COMP 8/19/2009
gamma-BHC	µg/kg dw	5.0 U	--	--	--	--	--	--
delta-BHC	µg/kg dw	5.0 U	--	--	--	--	--	--
alpha-Chlordane	µg/kg dw	5.0 U	--	--	--	--	--	--
gamma-Chlordane	µg/kg dw	5.0 U	--	--	--	--	--	--
Total chlordane	µg/kg dw	10 U	--	--	--	--	--	--
alpha-Endosulfan	µg/kg dw	5.0 U	--	--	--	--	--	--
beta-Endosulfan	µg/kg dw	10 U	--	--	--	--	--	--
Endosulfan sulfate	µg/kg dw	10 U	--	--	--	--	--	--
Endrin	µg/kg dw	10 U	--	--	--	--	--	--
Endrin aldehyde	µg/kg dw	10 U	--	--	--	--	--	--
Endrin ketone	µg/kg dw	10 U	--	--	--	--	--	--
Heptachlor	µg/kg dw	5.0 U	--	--	--	--	--	--
Heptachlor epoxide	µg/kg dw	5.0 U	--	--	--	--	--	--
Methoxychlor	µg/kg dw	50 U	--	--	--	--	--	--
Mirex	µg/kg dw	10 U	--	--	--	--	--	--
cis-Nonachlor	µg/kg dw	10 U	--	--	--	--	--	--
trans-Nonachlor	µg/kg dw	10 U	--	--	--	--	--	--
Oxychlordane	µg/kg dw	10 U	--	--	--	--	--	--
Toxaphene	µg/kg dw	500 U	--	--	--	--	--	--
Grain size								
Total gravel	% dw	32.5	55.8	32.0	3.5	--	--	--
Total sand	% dw	40.8	42.2	63.8	18.4	--	--	--
Total silt	% dw	16.9	--	--	45.3	--	--	--
Total clay	% dw	9.7	--	--	32.9	--	--	--
Total fines (percent silt+clay)	% dw	26.6	--	--	78.2	--	--	--
Conventionals								
Ammonia	mg-N/kg dw	7.57	3.68	3.71	18.8	--	--	--
Total organic carbon (TOC)	% dw	3.15	1.47	3.28	2.58	--	--	--
Total solids	% ww	60.50	66.40	69.90	47.20	--	--	--
Total solids (preserved)	% ww	60.80	76.00	73.00	44.60	--	--	--
Total sulfides	mg/kg dw	156 J	745 J	1,790 J	1,030 J	--	--	--

Notes:
µg/kg: micrograms per kilogram
mg/kg: milligrams per kilogram
ng/kg: nanograms per kilogram
OCDD: octachlorodibenzodioxin
OCDF: octachlorodibenzofuran
PCB: polychlorinated biphenyl
TEQ: toxic equivalency quotient

East Waterway Subsurface Sediment Chemistry

		EW10-SC06					EW10-SC08					EW10-SC09				
		EW10-SC06-0-2	EW10-SC06-2-4	EW10-SC06-4-6	EW10-SC06-6-7.4	EW10-SC06-7.4-10	EW10-SC08-0-2	EW10-SC08-2-4	EW10-SC08-6-8	EW10-SC08-8-9.4	EW10-SC08-9.4-11	EW10-SC09-0-2	EW10-SC09-2-4	EW10-SC09-6-7.2	EW10-SC09-7.2-9.2	EW10-SC09-9.2-11.2
		0 - 2 ft	2 - 4 ft	4 - 6 ft	6 - 7.4 ft	7.4 - 10 ft	0 - 2 ft	2 - 4 ft	6 - 8 ft	8 - 9.4 ft	9.4 - 11	0 - 2 ft	2 - 4 ft	6 - 7.2 ft	7.2 - 9.2 ft	9.2 - 11.2 ft
Chemical	**Unit**	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	3/9/2010	3/9/2010	3/9/2010	3/9/2010	3/9/2010
Metals																
Antimony	mg/kg dw	10 UJ	10 UJ	--	--	--	9 UJ	10 UJ	--	--	--	10 UJ	10 UJ	--	--	--
Arsenic	mg/kg dw	24.4	13.6	--	--	--	18.5	22.5	--	--	--	21.5	21.5	--	--	--
Cadmium	mg/kg dw	3.1	3.6	--	--	--	2.1	5.6	1.2	--	--	2.1	3.1	--	--	--
Chromium	mg/kg dw	72	45	--	--	--	53.9	118	--	--	--	52	72	--	--	--
Cobalt	mg/kg dw	10.5	6.5	--	--	--	13.1	16.4	--	--	--	9.9	11.0	--	--	--
Copper	mg/kg dw	130	70.2	--	--	--	129	157	--	--	--	126	141	--	--	--
Lead	mg/kg dw	197	169	--	--	--	162	272	--	--	--	155	253	--	--	--
Mercury	mg/kg dw	0.90	0.80	0.71	0.28	0.02 U	0.49	1.00	0.43	0.04	0.03 U	0.51 J	0.89 J	0.74	0.03 U	0.03 U
Molybdenum	mg/kg dw	6	9	--	--	--	3.7	7	--	--	--	4	5	--	--	--
Nickel	mg/kg dw	31	20	--	--	--	39	62	--	--	--	27	32	--	--	--
Selenium	mg/kg dw	1 U	1 U	--	--	--	0.9 U	1 U	--	--	--	1	1	--	--	--
Silver	mg/kg dw	3.7	1.8	--	--	--	1.6	5.8	--	--	--	1.3	2.6	--	--	--
Thallium	mg/kg dw	0.4 U	0.4 U	--	--	--	0.4 U	0.5	--	--	--	0.4 U	0.5 U	--	--	--
Vanadium	mg/kg dw	74.7	60.8	--	--	--	82.9	84.3	--	--	--	70.3	76.5	--	--	--
Zinc	mg/kg dw	287	253	--	--	--	321	382	--	--	--	282	350	--	--	--
Organometals																
Monobutyltin as ion	µg/kg dw	3.6 U	3.8 U	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibutyltin as ion	µg/kg dw	15	5.3 U	--	--	--	--	--	--	--	--	--	--	--	--	--
Tributyltin as ion	µg/kg dw	63 J	4.5 J	--	--	--	--	--	--	--	--	--	--	--	--	--
PAHs																
1-Methylnaphthalene	µg/kg dw	32 U	19 J	--	--	--	28 U	20 J	19 UJ	--	--	94	67	270 J	260	--
2-Chloronaphthalene	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
2-Methylnaphthalene	µg/kg dw	18 J	28 J	--	--	--	15 J	39	19 U	--	--	82	66	420 U	40	--
Acenaphthene	µg/kg dw	32 U	47	--	--	--	14 J	37 U	92	--	--	170	110	770	160	--
Acenaphthylene	µg/kg dw	37	38	--	--	--	34	37 U	19 U	--	--	110	200	220 J	20 U	--
Anthracene	µg/kg dw	90	180	--	--	--	90	290	160	--	--	630	1,400	3,000	20 U	--
Benzo(a)anthracene	µg/kg dw	140	330	--	--	--	170	560	160	--	--	760	2,400	3,600	20 U	--
Benzo(a)pyrene	µg/kg dw	350	330	--	--	--	360	520	110	--	--	1,300	2,300	2,500	20 U	--
Benzo(g,h,i)perylene	µg/kg dw	100	100	--	--	--	110	140	59	--	--	250	400	880	20 U	--
Total benzofluoranthenes	µg/kg dw	720	600	--	--	--	680	800	190	--	--	1,900	2,800	4,400	20 U	--
Chrysene	µg/kg dw	240	460	--	--	--	300	700	230	--	--	1,800	3,500	3,800	20 U	--
Dibenzo(a,h)anthracene	µg/kg dw	62	48 J	--	--	--	62	29 J	19 J	--	--	240 J	240 J	430	6.2 U	--
Dibenzofuran	µg/kg dw	32 U	36	--	--	--	28 U	25 J	56	--	--	52	63	340 J	20 U	--
Fluoranthene	µg/kg dw	250	810	--	--	--	260	1,200	680	--	--	1,900	3,000	8,100	20 U	--
Fluorene	µg/kg dw	17 J	68	--	--	--	20 J	57	120	--	--	220	180	900	20 U	--
Indeno(1,2,3-cd)pyrene	µg/kg dw	110	100	--	--	--	120	140	51	--	--	260	430	860	20 U	--
Naphthalene	µg/kg dw	31 J	73	--	--	--	29	33 J	17 J	--	--	94	130	680	950	--
Phenanthrene	µg/kg dw	130	260	--	--	--	120	170	680	--	--	1,500	1,000	3,700	20 U	--
Pyrene	µg/kg dw	640	810	--	--	--	520	1,500	580	--	--	2,600 J	4,300 J	10,000	20 U	--
Total HPAHs	µg/kg dw	2,610	3,590 J	--	--	--	2,580	5,600 J	2,080 J	--	--	11,000 J	19,400 J	35,000	20 U	--
Total LPAHs	µg/kg dw	310 J	670	--	--	--	310 J	550 J	1,070 J	--	--	2,700	3,000	9,300 J	1,110	--
cPAHs - mammal - half DL	µg/kg dw	470	460 J	--	--	--	480	690 J	160 J	--	--	1,700 J	3,000 J	3,600	14 U	--
Total PAHs	µg/kg dw	2,920 J	4,250 J	--	--	--	2,890 J	6,100 J	3,150 J	--	--	13,700 J	22,400 J	44,000 J	1,110	--
Phthalates																
Bis(2-ethylhexyl)phthalate	µg/kg dw	880 U	470 U	--	--	--	610 U	3,300	18 J	--	--	260	630	1,800	23	--
Butyl benzyl phthalate	µg/kg dw	63 J	15 U	--	--	--	55 J	66 J	18 J	--	--	47	76	52 J	16 U	--
Diethyl phthalate	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	15 U	--	--	20 U	20 U	15 U	20 U	--
Dimethyl phthalate	µg/kg dw	16 J	15 U	--	--	--	15 U	15 U	15 U	--	--	19	16	15 U	16 U	--
Di-n-butyl phthalate	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	44	20 U	420 U	20 U	--
Di-n-octyl phthalate	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
Other SVOCs																
1,2,4-Trichlorobenzene	µg/kg dw	15 J	6.1 U	--	--	--	6.0 U	6.1 U	6.0 U	--	--	6.1 U	7.4	14 U	6.2 U	--
1,2-Dichlorobenzene	µg/kg dw	6.1 U	6.1 U	--	--	--	6.0 U	6.1 U	6.0 U	--	--	6.1 U	6.2 U	6.1 U	6.2 U	--
1,3-Dichlorobenzene	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
1,4-Dichlorobenzene	µg/kg dw	12	6.1 U	--	--	--	16	15	6.0 U	--	--	21	15	8.5	6.2 U	--
2,4,5-Trichlorophenol	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
2,4,6-Trichlorophenol	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
2,4-Dichlorophenol	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
2,4-Dimethylphenol	µg/kg dw	6.1 U	6.1 U	--	--	--	6.0 U	6.1 U	6.0 U	--	--	20	17	6.1 U	8.7	--
2,4-Dinitrophenol	µg/kg dw	320 U	340 U	--	--	--	280 U	370 U	190 U	--	--	200 U	200 U	4,200 U	200 U	--
2,4-Dinitrotoluene	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
2,6-Dinitrotoluene	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
2-Chlorophenol	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
2-Methylphenol	µg/kg dw	6.1 U	6.1 U	--	--	--	6.0 U	6.1 U	6.0 U	--	--	8.5	7.4	6.1 U	6.2 U	--
2-Nitroaniline	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
2-Nitrophenol	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	19 U	--	--	98 U	99 U	420 U	20 U	--
3,3'-Dichlorobenzidine	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
3-Nitroaniline	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
4,6-Dinitro-o-cresol	µg/kg dw	320 U	340 U	--	--	--	280 U	370 U	190 U	--	--	200 U	200 U	4,200 U	200 U	--
4-Bromophenyl phenyl ether	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
4-Chloro-3-methylphenol	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--

East Waterway Subsurface Sediment Chemistry

		EW10-SC06					EW10-SC08					EW10-SC09				
		EW10-SC06-0-2	EW10-SC06-2-4	EW10-SC06-4-6	EW10-SC06-6-7.4	EW10-SC06-7.4-10	EW10-SC08-0-2	EW10-SC08-2-4	EW10-SC08-6-8	EW10-SC08-8-9.4	EW10-SC08-9.4-11	EW10-SC09-0-2	EW10-SC09-2-4	EW10-SC09-6-7.2	EW10-SC09-7.2-9.2	EW10-SC09-9.2-11.2
		0 - 2 ft	2 - 4 ft	4 - 6 ft	6 - 7.4 ft	7.4 - 10 ft	0 - 2 ft	2 - 4 ft	6 - 8 ft	8 - 9.4 ft	9.4 - 11	0 - 2 ft	2 - 4 ft	6 - 7.2 ft	7.2 - 9.2 ft	9.2 - 11.2 ft
Chemical	**Unit**	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	3/9/2010	3/9/2010	3/9/2010	3/9/2010	3/9/2010
4-Chloroaniline	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
4-Chlorophenyl phenyl ether	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
4-Methylphenol	µg/kg dw	20 J	76	--	--	--	15 J	37 U	19 U	--	--	16 J	18 J	420 U	20 U	--
4-Nitroaniline	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
4-Nitrophenol	µg/kg dw	160 U	170 U	--	--	--	140 U	180 U	97 U	--	--	98 U	99 U	2,100 U	98 U	--
Aniline	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
Benzoic acid	µg/kg dw	320 U	340 U	--	--	--	280 U	370 U	190 U	--	--	200 U	71 J	4,200 U	200 U	--
Benzyl alcohol	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	30 U	20 U	--
bis(2-chloroethoxy)methane	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
bis(2-chloroethyl)ether	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
bis(2-chloroisopropyl)ether	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
Carbazole	µg/kg dw	32 U	34 U	--	--	--	28	37 U	19 J	--	--	170	250	280 J	110	--
Hexachlorobenzene	µg/kg dw	6.1 U	6.1 U	--	--	--	6.0 U	6.1 U	6.0 U	--	--	6.1 U	6.2 U	6.1 U	6.2 U	--
Hexachlorobutadiene	µg/kg dw	6.1 U	6.1 U	--	--	--	6.0 U	6.1 U	6.0 U	--	--	6.1 U	6.2 U	6.1 U	6.2 U	--
Hexachlorocyclopentadiene	µg/kg dw	160 U	170 U	--	--	--	140 U	180 UJ	97 U	--	--	98 UJ	99 UJ	2,100 U	98 U	--
Hexachloroethane	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
Isophorone	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
n-Nitroso-di-n-propylamine	µg/kg dw	30 U	31 U	--	--	--	30 U	30 U	30 U	--	--	30 U	31 U	34 J	31 U	--
n-Nitrosodimethylamine	µg/kg dw	30 U	31 U	--	--	--	30 U	30 U	30 U	--	--	30 U	31 U	30 U	31 U	--
n-Nitrosodiphenylamine	µg/kg dw	7.3 U	6.1 U	--	--	--	6.6 U	21 U	8.4 U	--	--	10 U	20 U	46 U	6.2 U	--
Nitrobenzene	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	20 U	--
Pentachlorophenol	µg/kg dw	30 U	31 U	--	--	--	30 U	52	30 U	--	--	30 U	81	30 U	31 U	--
Phenol	µg/kg dw	32 U	34 U	--	--	--	28 U	37 U	19 U	--	--	20 U	20 U	420 U	33	--
PCBs																
Aroclor-1016	µg/kg dw	41 U	3.9 U	--	--	--	40 U	110 U	3.9 U	--	--	49 U	48 U	37 U	19 U	--
Aroclor-1221	µg/kg dw	41 U	3.9 U	--	--	--	40 U	110 U	3.9 U	--	--	49 U	48 U	37 U	19 U	--
Aroclor-1232	µg/kg dw	41 U	3.9 U	--	--	--	40 U	110 U	3.9 U	--	--	49 U	48 U	37 U	19 U	--
Aroclor-1242	µg/kg dw	250	3.9 U	--	--	--	180	110 U	3.9 U	--	--	49 U	48 U	37 U	19 U	--
Aroclor-1248	µg/kg dw	41 U	20 U	--	--	--	40 U	2,400	3.9 U	--	--	140	240	340	19 U	--
Aroclor-1254	µg/kg dw	1,000	37 J	--	--	--	540	2,800	3.9 U	--	--	390	660	620	19 U	--
Aroclor-1260	µg/kg dw	1,300	72	--	--	--	680	2,000	3.9 U	--	--	640	1,000	760	19 U	--
Aroclor-1262	µg/kg dw	41 U	3.9 U	--	--	--	40 U	110 U	3.9 U	--	--	49 U	48 U	37 U	19 U	--
Aroclor-1268	µg/kg dw	41 U	3.9 U	--	--	--	40 U	110 U	3.9 U	--	--	49 U	48 U	37 U	19 U	--
Total PCBs	µg/kg dw	2,600	109 J	--	--	--	1,400	7,200	3.9 U	--	--	1,170	1,900	1,720	19 U	--
Dioxin/furan																
2,3,7,8-TCDD	ng/kg dw	--	--	--	0.319 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDD	ng/kg dw	--	--	--	0.910 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDD	ng/kg dw	--	--	--	1.10 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDD	ng/kg dw	--	--	--	0.864 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDD	ng/kg dw	--	--	--	0.885 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDD	ng/kg dw	--	--	--	6.30	--	--	--	--	--	--	--	--	--	--	--
OCDD	ng/kg dw	--	--	--	24.4	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF	ng/kg dw	--	--	--	1.42	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDF	ng/kg dw	--	--	--	0.934 J	--	--	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PeCDF	ng/kg dw	--	--	--	1.02 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDF	ng/kg dw	--	--	--	0.598 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDF	ng/kg dw	--	--	--	0.557 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDF	ng/kg dw	--	--	--	2.43 U	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HxCDF	ng/kg dw	--	--	--	0.480 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	ng/kg dw	--	--	--	1.04 J	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	ng/kg dw	--	--	--	2.43 U	--	--	--	--	--	--	--	--	--	--	--
OCDF	ng/kg dw	--	--	--	0.435 J	--	--	--	--	--	--	--	--	--	--	--
Total TCDD	ng/kg dw	--	--	--	64.0 J	--	--	--	--	--	--	--	--	--	--	--
Total PeCDD	ng/kg dw	--	--	--	64.5 J	--	--	--	--	--	--	--	--	--	--	--
Total HxCDD	ng/kg dw	--	--	--	41.3 J	--	--	--	--	--	--	--	--	--	--	--
Total HpCDD	ng/kg dw	--	--	--	13.9	--	--	--	--	--	--	--	--	--	--	--
Total TCDF	ng/kg dw	--	--	--	32.7 J	--	--	--	--	--	--	--	--	--	--	--
Total PeCDF	ng/kg dw	--	--	--	12.6 J	--	--	--	--	--	--	--	--	--	--	--
Total HxCDF	ng/kg dw	--	--	--	5.04 J	--	--	--	--	--	--	--	--	--	--	--
Total HpCDF	ng/kg dw	--	--	--	1.38	--	--	--	--	--	--	--	--	--	--	--
Dioxin/furan TEQ - bird (half DL)	ng/kg dw	--	--	--	4.23 J	--	--	--	--	--	--	--	--	--	--	--
Dioxin/furan TEQ - fish (half DL)	ng/kg dw	--	--	--	2.74 J	--	--	--	--	--	--	--	--	--	--	--
Dioxin/furan TEQ - mammal (half DL)	ng/kg dw	--	--	--	2.37 J	--	--	--	--	--	--	--	--	--	--	--
Grain size																
Total gravel	% dw	0.7	3.9	--	--	--	0.1 U	0.4	--	--	--	7.5	5.6	--	--	--
Total sand	% dw	20.6	56.7	--	--	--	13.4	16.6	--	--	--	23.2	23.2	--	--	--
Total silt	% dw	47.7	20.3	--	--	--	50.1	48.2	--	--	--	46.9	43.0	--	--	--
Total clay	% dw	31.2	19.0	--	--	--	36.5	34.9	--	--	--	22.5	28.3	--	--	--
Total fines (percent silt+clay)	% dw	78.9	39.3	--	--	--	86.6	83.1	--	--	--	69.4	71.3	--	--	--
Conventionals																
Total organic carbon (TOC)	% dw	3.69	7.40	4.32	2.32	1.18	1.45	2.42	2.29	0.694	0.427	3.99	5.29	4.39	0.403	0.424
Total solids	% ww	48.70	48.20	47.87	60.40	78.50	50.10	47.60	59.20	70.30	77.80	40.80	40.70	52.60	77.30	75.70

East Waterway Subsurface Sediment Chemistry

Chemical	Unit	EW10-SC06					EW10-SC08					EW10-SC09				
		EW10-SC06-0-2	EW10-SC06-2-4	EW10-SC06-4-6	EW10-SC06-6-7.4	EW10-SC06-7.4-10	EW10-SC08-0-2	EW10-SC08-2-4	EW10-SC08-6-8	EW10-SC08-8-9.4	EW10-SC08-9.4-11	EW10-SC09-0-2	EW10-SC09-2-4	EW10-SC09-6-7.2	EW10-SC09-7.2-9.2	EW10-SC09-9.2-11.2
		0 - 2 ft	2 - 4 ft	4 - 6 ft	6 - 7.4 ft	7.4 - 10 ft	0 - 2 ft	2 - 4 ft	6 - 8 ft	8 - 9.4 ft	9.4 - 11	0 - 2 ft	2 - 4 ft	6 - 7.2 ft	7.2 - 9.2 ft	9.2 - 11.2 ft
		2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	2/22/2010	3/9/2010	3/9/2010	3/9/2010	3/9/2010	3/9/2010

Notes:
µg/kg: micrograms per kilogram
mg/kg: milligrams per kilogram
ng/kg: nanograms per kilogram
OCDD: octachlorodibenzodioxin
OCDF: octachlorodibenzofuran
PCB: polychlorinated biphenyl
TEQ: toxic equivalency quotient